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VIEWS, NEWS AND INTERVIEWS.

A Texas farmer entered the office of a Dallas, Tex., merchant prince, and asked him if he would like to buy some fresh butter which he had brought to town in his wagon.

"I really don't know whether my wife needs any butter just now, but I'll find out," replied the merchant, and stepping to the telephone he called up his wife and had some conversation on the subject. Then he turned to the countryman, who had watched the proceedings, and whose face was a study for an artist.

"No," said the merchant, "my wife tells me that she has butter enough on hand to last her for some time."

"That's all right, Cap. You don't need to buy any butter if you don't want to. All you have got to do is to say so, but you needn't play me for a fool by trying to make me believe you have got your wife locked up in that little box. I reckon I have some sense left, if I am from the country. You can't fool me."

In the Electricity Building at the World's Fair, Chicago, there will be 40,000 panes of glass—or more than any other Exposition structure. This building will be especially conspicuous at night, as, owing to its extensive glass surface, the brilliancy of its electrical exhibit will be strikingly visible from the outside.

The Western Union Telegraph Company has adopted blue envelopes as the distinguishing feature of local messages. Messages from distant points are still enclosed in the old corn-colored envelopes.

Electrolytic Gas Experiments.

An interesting experiment has been lately made by M. Chabry, of the Société de Biologie, with regard to the pressure which can be produced by electrolytic generation of gas in a closed space. While the highest pressure before realized in this way was 6,570 pounds to the square inch (447 atmospheres, Gassiot), M. Chabry has succeeded in getting as high as 12,000 or 18,000 pounds to the square inch, and the experiment was broken off merely because the manometer cracked (without explosion). The electrolyzed liquid was a 25 per cent. soda solution. Both electrodes were of iron—one was the hollow sphere in which the gas was collected, the other an inner concentric tube. The current employed was 1½ amperes, and was very constant during the experiment, which was merely one preliminary to research in which very high pressures were desired.

PERSONAL.

Mr. A. J. Corriveau, of Montreal, spent a day or two in the metropolis last week.

A number of the attendants at the Buffalo Convention visited New York on their way home.

Mr. W. A. Jackson, of the Detroit Electrical Works, Detroit, Mich., was a recent visitor to New York, and favored the REVIEW office with a call.

New York Press Club Dinner.

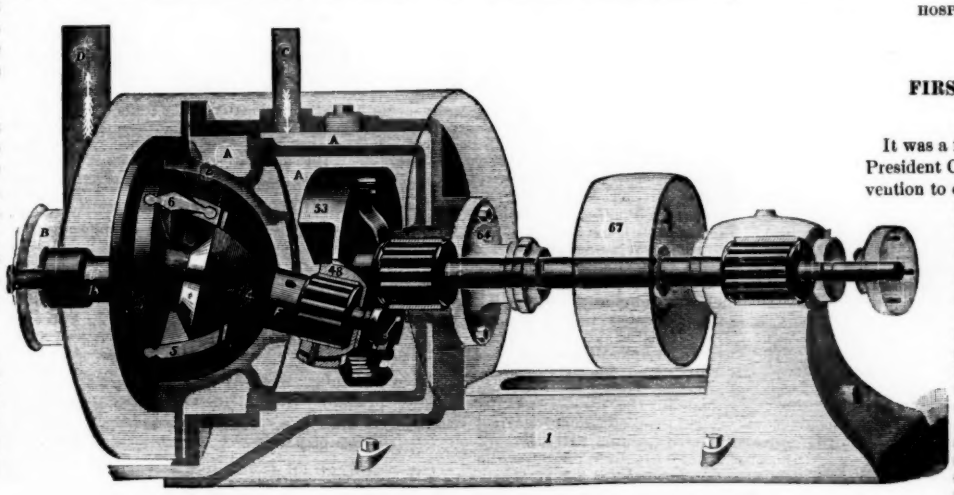
The annual dinner of the New York Press Club, Saturday evening of last week, was a highly enjoyable and notable event. A particularly fine dinner was splendidly served by the Metropolitan Hotel and music by the Park Sisters, singing hits by the "disturbance committee," composed of Press Club artists, and brilliant, humorous speeches by Gen. Horace Porter, Hon. Chauncey M. Depew, Gen. Chas. H. Taylor, Rev. Dr. Geo. R. Vandewater and others, made up an evening that will never be forgotten by every one privileged to be present. Mayor Grant was present and spoke a few pleasant words to the press boys. It was undoubtedly the most successful annual dinner in the history of the Club. Immediately after the 300 or more had taken their seats, Ernest Jerrold ("Micky Finn"), of the Club, in a clear, sweet, tenor voice, sang the Club song, "Then Scatter Seeds of Kindness," and everybody felt good from that moment on. Col. John A. Cockerill, president of the Club, presided with his accustomed grace, and he and the the executive commitee, composed of Chas. O. C. Hennessy, Chas. F. Hart, Chas. W. Price, Foster Coates and Chas. T. Arnoux, received numerous congratulations over the success of the occasion for which they had labored so earnestly.

There were present, in addition to the above-named, Messrs. Murat Halstead, Erastus Wiman, Augustus Thomas, George H. Daniels, Joe Howard, Jr., William Berri, E. B. Harper, A. B. DeFreece, John C. Tomlinson, Chester S. Lord, Arthur Brisbane, William N. Penney, Cornelius Van Cott, F. J. Allen, H. D. Winton, J. W. Keller, J. R. Graham, Thomas H. Evans, Joe Kerr, Marshall P. Wilder, George W. Turner, Ralph Meeker, S. C. Austin, George H. Lowerre, Milton C. Roach, J. I. Charlouis, Charles W. Burnham, C. H. K. Curtis, W. S. Andrews, W. D. Sargent, Charles S. Gleed, John A. McCall, J. I. C. Clarke, Charles J. Perry, E. R. Bedloe, John Frederick, George M. Phelps, T. C. Martin, E. L. Ridgeway and some 250 others.

The American High Speed Engine.

The novel engine which constitutes the caption of this article should not be confounded with the ordinary high speed reciprocating engines. The latter are capable of making only 300 or 400 revolutions per minute, whereas, the American can be governed so as to run easily at any speed desired up to 1,000 or more per minute. It is not a rotary engine pure and simple, and yet the motion of its parts is such that there are no dead centers. It may be coupled directly to dynamo electric machines, circular saws, or any other machines requiring great velocity. Its piston is a waddling spherical segment perfectly balanced by having a cushion of steam, which also reduces the friction and renders the engine smooth running and noiseless.

The engine can be compactly built and all of the operative parts except the driving shaft are enclosed within the exterior case of the cylinder.



AMERICAN HIGH SPEED ENGINE. [INTERIOR VIEW.]

FIG. 1.

An idea of the structure of the engine may be gathered from an examination of the accompanying engravings, of which Fig. 1 illustrates the operative parts, some of which are shown in phantom; 1 represents the bedplate, 2 the cylinder, 3 the cylinder-head, 4 the piston, 5 and 6 the partition blades at the piston, 48 the spherical bushing by which the connection between the piston and the crank disk 53 is established, 18 the follower-pin, 64 the stuffing box, A the steam chest, B the exhaust chest, C the live steam pipe, D the exhaust steam pipe.

The piston is a segment of a sphere and fits into the cylinder which is concaved to receive it. The cylinder also has a circular opening through which projects a stem F centrally located on the piston. The opening admits steam from the steam chest 8 at the back of the piston, its area being so proportioned as to balance the pressure of steam in the compartments between the blades 5 and 6, thus reducing the friction on the cylinder surfaces. There are four partition blades, such as 5 and 6, at equal distances, dividing the space between the piston and

(Continued on page 17.)

FIFTEENTH CONVENTION

NATIONAL ELECTRIC LIGHT ASSOCIATION AT BUFFALO, FEBRUARY 23, 24 AND 25.

A Large Attendance, and a Particularly Successful Meeting.

VALUABLE AND INSTRUCTIVE PAPERS BY MESSRS. STANLEY, PECK, HERING, SCHIEREN, STILLWELL, LESLIE, WIMAN AND OTHERS.

ST. LOUIS THE NEXT MEETING PLACE—MR. JAMES I. AYER, OF THAT CITY, ELECTED PRESIDENT—BUFFALO'S HOSPITALITY—GENERAL NOTES—ETC., ETC.

FIRST DAY—FEBRUARY 23.

Forenoon Session.

It was a few minutes after 11 o'clock when President Charles R. Huntley called the Convention to order in the meeting hall at the Iroquois Hotel and introduced Mayor Bishop, who was received with applause and spoke in a very pleasant vein in making his address of welcome. He said:

Mr. President, Ladies and Gentlemen: It might seem as if there were an element of irony in welcoming the representatives of the electric light companies to this city. Judging from the common speech of people here an assembly of gentlemen who are at the head of the electric light companies and also those who are connected with them, especially their managers and attorneys, are not so modest as to require a welcome or an invitation to any place where good things are to be seen or to be had (applause), and it is but fair to infer that electric light men coming from other localities have the same like assurance. I would not have you think that the city of Buffalo is at war with her electric light benefactors. To be sure they do about as they please and they take what they want (laughter), but they do it so adroitly, so graciously, and with such abundant good nature, that we rather enjoy our good things which are taken.

Mr. President and ladies and gentlemen, it affords me great pleasure to have the privilege, on behalf of the citizens of Buffalo, of extending to you a hearty welcome.

I will conclude, gentlemen, by saying that when your labors are here completed and you return to your homes, I hope you take with you only pleasant memories and a desire to visit us again. Again, ladies and gentlemen, on behalf of the citizens of Buffalo, I extend to you one and all a hearty and fraternal welcome and the freedom of the city, without reserve. (Loud applause.)

PRESIDENT HUNTLEY'S ADDRESS.

President Huntley's annual address was a thoughtful paper and was listened to with close attention. He spoke as follows:

Gentlemen and Fellow Members of the Association: In behalf of the National Electric Light Association, I am glad to welcome to our meeting to-day those who represent the city and public of Buffalo, and as a citizen of Buffalo and president of this

body, I am not less happy in adding my own welcome to those which greet the visit of the Association to this, the Queen City of the Lakes, a city far enough West to have all the bustle and energy of Chicago, but still far enough East to exhibit the dignity and solidity of New York.

The meeting of this Association so near to Niagara seems to afford a fitting opportunity for the discussion of the problem which is attaining great importance day by day, namely, the electrical transmission of power. Whether we are engaged in the distribution of electric light by arc or incandescent lamps, or in generating current for stationary or railway motors, or for heating, we are essentially engaged in generating, distributing and converting power into its various forms; hence, any method by which the initial power can be obtained in a manner or from a source of greater economy deserves our most serious consideration.

The question may, therefore, naturally be asked: What would be the effect of the utilization of Niagara or other large water powers, so far as concerning outlying cities? How far will it be possible to transmit this power, not theoretically, or in an experimental way, but commercially, so as to insure a fair dividend to the investor? At what point does it become cheaper to carry current than to carry coal? Now, these are large questions. They are, in fact, the largest problems in modern engineering. When you come to deal with such an immense and incalculable source of power as Niagara, our previous plans and methods and successes sink into nothing, as indicative of final results and realizations. Our attitude toward such a taming of nature is very much the same as that of the first electrical experimenters when they interrogated her with the help of pith balls and little chips of amber. Even the late demonstration at Frankfort teaches us little, for there we had the utilization of only such a water power as a well-to-do American citizen puts in his backyard for ornamental purposes, and the experiment was tried in Summer time when winds are light and skies are clear. Moreover, that plant was run as an exhibition, with the Emperor of Germany and other dignitaries lending a patriotic hand and subscribing patriotic dollars. Now, gentlemen, when you and I who operate stations come to use such water powers, or distant coal beds, we shall not be able to fall back on kindly emperors for timely donations. Some of our fellow citizens will be quite ready to help us, but with the instinct that is born in every American, they will want the dollar they pay out to bring another back with it.

Our field of work, in short, with its newness and rawness, is one in which experience must always moderate enthusiasm. To me, perhaps, more than to many of my fellow members, this question of long distance power transmission is fraught with large possibilities and grave responsibilities. It is imperative that I should know the truth and the facts; and if ever the time comes when I can be humbly instrumental in giving Buffalo a sparkling midnight firmament created by yonder Falls, I shall ask no grander task. I have ventured to make this momentous subject one of the leading topics here, and my call for information has been responded to by some of the most authoritative workers and thinkers in this direction. To them I shall leave the exposition of its details, with the conviction that you will forgive me if, under a sense of duty, I have indicated the practical limitations that must govern every man of affairs.

In this connection I cannot help pointing out again that, after all, the cost of coal to operate an electric plant is only one among many items, and frequently a small percentage of the total cost at that. For instance, in electric railway work the cost of coal comes to about 10 per cent. of the total operating expenses, while in electric lighting it probably does not exceed from 15 to 20 per cent. In these days, when municipal plants are the subject of frequent discussion, these facts are generally lost sight of, and the cost of electric lights is calculated by reference to the amount of coal burned under the boiler, thus ignoring the fact that firemen, engineers, linemen, trimmers, etc., are required; that carbons require daily renewal and globes break; that, like all other machinery, engines, boilers, dynamos and lamps are subject to depreciation, require repairs, that the building must be insured, and that a sinking fund must be established for renewals.

Cheap power in itself would, therefore, influence the cost of electric lighting very little, even if the electric current is distributed in the immediate vicinity where it is generated; while its distribution to any considerable distance in large power units on a commercial basis seems to be awaiting its demonstration here rather than in Europe. Hence I would recommend a study of the facts pointed out, which ought to make any community falter before investing in a municipal plant simply because it may happen to have what is supposed to be a cheap source or power around the corner.

Municipal ownership is, as I have just intimated, a topic that some of you have to deal with directly. This Association has always been a forum to which new ideas in the industry might be brought, and our efforts have done not a little in clearing away the haze and confusion on the subject of municipal control and operation. I have made a special effort, as evidence of our impartiality, to get together at this meeting some of those why believe in the abolition of private enterprise and in the surrender of all the ideas that make us crave for a home of our own and the accumulation of a few dollars for a rainy day. If we are wrong in the operation that self-help is the best help, and that ten well-to-do citizens count more for the community that 20 superfluous office-holders, it is time we knew it. Some people want the government to run the railroads and some want it to buy up the telegraphs and telephones. Others want the municipalities to own street railways, gas works and electric light plants. In Boston there is, I am told, a demand that the city shall collect more taxes and put it into public coal yards. I am reminded of my reading, as a boy at school, when I learned that the foredoomed population of a great city once sent up a howl for free bread and free tickets to the circus. Now, let me say right here that public franchises are a public trust. In return for them we are to do something or agree something that the community wants. In my humble judgment it has yet to be proved that such a way of introducing improvements and benefits is wrong or foolish. I am a busy man and have been earning a livelihood all my life, but I have had time enough to observe that the whole vast industrial development that has added so enormously to the comfort and happiness of life has come from the investment, under public franchises, of private capital, skill and enterprise. The public has thus been made the partner in all the great works of the age, and has thus gained infinitely more than it could have secured if it had raised an equal amount of money by taxation, and had placed the proceeds in the hands of a vast body of office-holders for the same purposes.

Among the questions that interest us are these that concern the relations between the so-called parent companies and ourselves, the local companies, operating the apparatus that the parent companies sell. I am aware that in some quarters the consolidations that have been effected from time to time are viewed with anxiety, and that in others the cry of bad faith has been raised—not perhaps, without warrant. But consolidations have their hopeful, better side. At one period our respective territories were practically open ground for 30 or 40 competing manufacturers, each of whom had the best system in existence. That fierce and wasteful local competition should be engendered under such conditions was inevitable, and even to-day the industry is hampered by the central stations that came into being under this unwholesome outside stimulus. We were, I must say, peaceful farmers whose early and promising crops were an invitation to every raider that could reach us. But at the present time the situation is clearing. The various consolidations let us see pretty clearly with whom we were dealing, and we know, too, something of the value of the claims made for the apparatus or the patents that protect it. We have also learned that much apparatus essential to good work is free from patent royalties, and that the moment prices go beyond the point of paying a fair manufacturer's profit, a dozen big engineering firms are ready to invest with capital and brains. My esteemed friend and predecessor, Mr. Weeks, has even suggested that we should combine and manufacture for ourselves. But there is no need for that. Dynamo and lamp construction has made a place for itself already as one of the arts, very few fundamental patents are left, and every day brings us nearer to the time when generator building will be as universally practised as engine building.

Meantime, we who run the stations have been learning hard lessons in the schools of experience, and that training is as valuable a part of our enterprise as are the franchises under which we have been induced to put our savings into the business of supplying light and power to our fellow citizens. Unfortunately, much of that experience remains a sealed book, and it is with the view of exchanging practical ideas that this Association carries on its work. I never meet one of my fellow workers in this field but he teaches me something; possibly I give him a little in return. Now, apply that principle on a broad scale, and we see how beneficial it must be to find out from each of two or three hundred earnest men their best way of doing things. That means progress, prosperity, perfection. But as long as only a few of us get together; as long as a feeling of apathy is allowed to control, our central station practice will fall far short of what it ought to be; it will not be as near standardization as it should be; and we will not make as much money as we ought. My political and social economy teaches me that the greater profit I can get out of any enterprise, with fair service and due satisfaction to the public, the better citizen I am. The rewards of society are for those who can increase its wealth and raise its degree of comfort and convenience. Now, the central station man who stays home is not doing his share to promote economical operations. I will go so far as to state that if once a year half the central stations of the country were represented in our gatherings, the average dividends would be increased, while not a few stations that now struggle on in dreary debt would reach a basis of solvency. I am very thoroughly in favor of one meeting a year for this Association, and of a systematic, energetic effort to get everybody there. Every member should make it his business to interest his neighbors in the work we are doing, especially the smaller stations.

As an inducement to the smaller stations, I would be glad to see the dues somewhat reduced so that they can come in without feeling that they are paying dearly for their whistle. There is no valid reason why the dues should be high, and if cutting them down will bring in the stations most to be benefited, no hesitation should be felt in taking such action.

It is important that we should interest ourselves in the World's Fair. I surely do not exaggerate when I say that every patriotic New Yorker wishes Chicago the biggest kind of success in her great undertaking, and admires the genuine American fashion in which the Western metropolis has sailed in to win. It is not only our duty, but it will be a source of great pleasure to contribute to the importance and success of the Exposition. We ought to meet in Chicago next year. We must go there in a body. The Chicago Electric Club is ready to take care of us, the whole city has a welcome for us, and the electric exhibit will be the finest the world has ever seen.

We have a good programme of papers for this Convention, and I ask you to do the authors the compliment of discussing them exhaustively. In these and other ways, you will strengthen the hands of the chair, promote the cause we are here to advocate, and make this meeting the best we have ever had.

Within this city, something like three or four weeks ago, a man, who perhaps, contributed as much in the early days of this Association to make it a success as anybody, after a long illness, passed away. I speak of Mr. George Worthington. I think it is proper that this body take suitable action in regard to his death, as to no man is the Association more indebted for its early growth than to George Worthington. He was a friend to everyone in the business; known to everybody, and, as a journalist, he ranked with any of them. I will be glad, should a committee be appointed, to draft suitable resolutions for this purpose.

Some very kind invitations were received. One was from the Delaney Forge and Iron Company, to go through their works. The Postal Telegraph Company offered the use of their facilities for the delegates to send social messages free. Free use of all telephone wires in the city and also of the long distance telephone wires to New York and elsewhere were offered.

The California Electrical Society sent a pressing invitation to hold the next convention in San Francisco. Referred to the Executive Committee.

The report of the Committee on Underground Conduits and Conductors was read, as follows:

REPORT OF COMMITTEE ON UNDERGROUND CONDUITS AND WIRES. — M. J. FRANCISCO, CHAIRMAN.

At the Providence meeting of the Association, a committee was appointed to investigate underground conduits and conductors, and collect data regarding their working. The committee, in carrying out this work, decided to send out circulars to all central stations and other parties using underground conduits, asking for information regarding its use and the success obtained. The following circular was printed and mailed:

"A committee was appointed at the annual convention of the National Electric Light Association, held in Providence, February, 1891, to investigate and collect data relating to underground conduits and conductors. In order to secure the full facts, answers to the following questions are desired. Will you kindly answer and return as soon as possible.

"1. Mileage of conduit laid?
"2. Cost of conduit per mile?
"3. Mileage of conduit in use?
"4. Mileage of duct laid?
"5. Mileage of duct in use?
"6. Average hours per diem same is operated.
"7. Number of manholes?
"8. Cost of manholes?
"9. Number of hand-holes?
"10. Cost of hand-holes?
"11. Number of services taken direct from conduit?
"12. Cost of maintenance per mile per month?
"13. Cost of repairs per mile per month?
"14. Average number of burn-outs and grounds per mile and the cause?
"15. Have you found the working of your underground system a commercial success?
"16. What is the voltage on each conductor?
"17. What is the current, in amperes, carried by each conductor?
"18. What is the size of the conductors used? (In answering this question give the number and gauge.)
"19. What is the thickness of the insulation?
"20. Who is the maker of the cables?
"21. Are the cables laid in any form of conduit?
"22. If so, what kind of conduit is used?
"23. Have the cables worked satisfactorily during the entire time of their use?
"24. If the cables have failed to work satisfactorily, to what cause do you attribute the difficulty? (Please answer as fully as possible.)
"25. Have you abandoned any conduits because they proved failures?

"The names of companies or stations will not be made public, but grouped by numbers. We wish this information for the benefit of every member of the National Electric Light Association."

It soon became apparent to the committee that they were treading upon very dangerous ground, nearly every man addressed at once concluding that there was a direct drive being made at him or his business, and the amount of ignorance displayed by parties who had used underground cable, and were supposed to know of its value and practical working, was rather alarming. Then a plan was adopted to secure from the manufacturers a list of parties who had purchased underground cable, with the intention of making personal examination of each plant. Here again the discovery was made that, with a few exceptions, the manufacturers did not know to whom they had sold underground cable and were unable to furnish the list. After these plans had failed, it was decided to investigate personally various plans and system in use, and the chairman of the committee started out on a voyage of discovery.

The committee found that what had answered the purpose in one city had proved a failure in another, owing to local troubles, such as the nature of the soil, gas, steam, and, in some cases, politics, which had a very peculiar effect upon the conduit itself, as well as the insulation used, and, in one city, we found that a liquid insulation, passed through the conduit in such a way that the officials could personally examine and test its efficiency and quality, was the only conduit or system they would approve or adopt.

In another city the central station company placed about 10 miles of underground conductor for an arc line, passing same through an iron pipe, relying upon the insulation of the wire; it utterly failed, and they took it out, then tried another make of wire, drawing it into that same iron pipe; this held for a short time and then began to burn out, and sometimes two feet of the wire would be entirely burned out, and when it was drawn out of the pipe you could blow dry powder in clouds from the pipe, showing that it was not moisture that caused the trouble. Another company tried a conduit made of three-inch tarred planks, using underground cable with $\frac{4}{32}$ inch insulation that was supposed to be first-class. On this they passed a 1,000 volt current. As soon as they started they had innumerable burn-outs, grounds and crosses, and finally abandoned it.

One company, using 1,100 volts and 50 amperes, tried passing cable through pump logs, with wire of $\frac{1}{16}$ inch insulation, and were troubled with grounds and burn-outs, and found the insulation was too thin, and had to be abandoned. Another company tried conduit made of asphalt, with several makes of wire, using 1,500 volts and 10 amperes, but did not work successfully on account of burn-outs, grounds and crosses, and abandoned the entire outfit.

In a municipal plant of one city, where the Dorsett system was used, also iron pipe with cement lining and other styles of conduit, it was stated the underground conduit was perfection, and could not be improved upon. A little private investigation developed the fact that one underground circuit had been in trouble for six months previous to our visit, and at that time the trouble had not been located, also that the voltage of the lamps varied from 25 to 55 volts.

Various plans were tried for lighting the Hoosac Tunnel. They used 1,000 volts, but the insulation was too thin and would not stand and they had constant trouble, as the tunnel is very wet and in many places wire was covered with water. They then tried another style of wire, using 1,000 volts, alternating current, lamps in series, 20 in each set, 1,250 lamps in all; since this plan was adopted, they have had no trouble and the same wire has been in use three years, running 24 hours per day.

The electric bureau of Philadelphia have

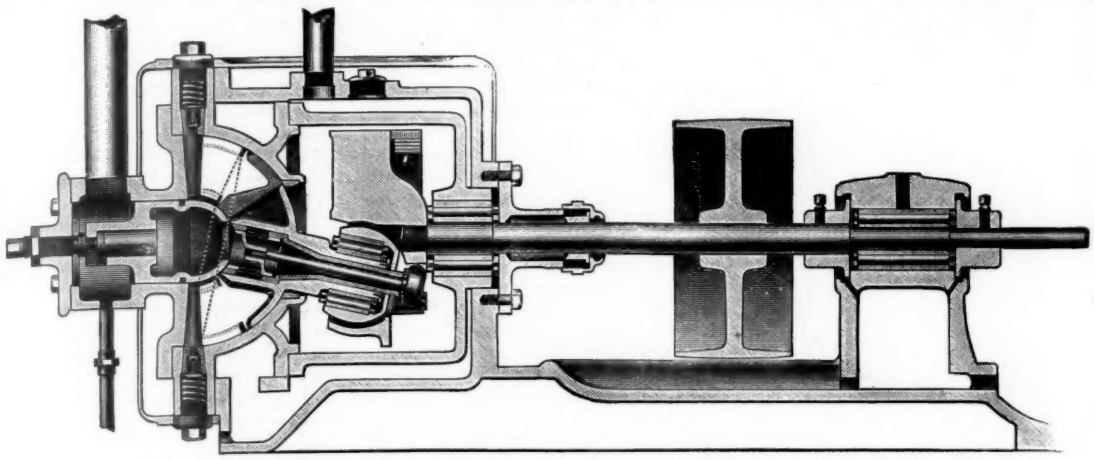
(*Continued on page 22.*)

THE AMERICAN HIGH SPEED ENGINE.

(Continued from First Page.)

the cylinder head 3 into four compartments The follower-pin 18 is made spherical on its inner end and fits into a socket in the piston, as indicated, thus forming a bearing for the piston and permitting the latter to turn as upon a universal joint. Means for adjusting this follower-pin are provided to compensate for wear. In operation the steam is led to the cylinder by the induction pipe C, whence it passes through the steam chest and the holes in the piston stem F to the cut-off valve located inside the piston, the details of which may be seen in Fig. 2; thence through a passage of the piston to one of the steam chambers or compartments between the piston 4 and the cylinder head 3, tending to force the piston away from the cylinder head. Inasmuch as the stem of the piston is prevented from moving in a direct line with the action of the steam by its connection with the crank disk 53, it is compelled to describe a circle with the axis of the shaft for its center. Steam continues to flow into this compartment until cut off by the cut-off valve, after which it continues to expand and throws the piston away from the cylinder head until the stroke is completed. The port through which steam entered the active compartment is then put in connection with the exhaust by the main valve and the steam passes out through the follower-pin 18, into the exhaust pipe D. In this manner steam is admitted to one compartment or steam chamber after another and keeps the shaft in continuous revolution. The time of opening and closing the ports for admission of steam is controlled by the automatic governor, which maintains a uniform speed under varying loads. This governor is indicated in Fig. 3, and is enclosed in the steam chest A and consists of two weights QQ, pivoted to the rear side of the crank disk 53 (see Fig. 1), these weights being connected with the stem of the cut-off valve by the rods *qq*, these rods being mounted in spherical sockets to permit the varying angle of the valve stem which they control, which angle, of course, varies as the valve stem and the cylinder change position. The governor weights are held down by steel springs bearing on rollers carried on a pivoted arm. These rollers may be adjusted by means of set screws so as to increase the tension of the springs. Thus the speed of the engine can be varied by adjusting the tension of the springs. The weights have a knife edge bearing against their supporting studs. The lubrication is supplied by the steam, and, therefore, long runs may be made without stopping to oil the governor

In Fig. 4 is illustrated the connection of one of the American high speed engines with a dynamo. The governor is exceedingly sensitive, turning at 1,000 revolutions per minute. It will be noted that this engine is very economical of floor space. A fly-wheel is unnecessary, which materially reduces the weight. The engine may be set in any position to suit the work to which it is to be applied, thus dispensing with intermediate shafting, pulleys, hangers and belting, not only resulting in a saving of expense but avoidance of friction with which those attachments are accompanied and the constant outlay and power they necessitate. It is claimed for the American engine that it gives an increased efficiency in conversion of the energy of the steam into power by reason of the high speed. The steam parts with but little of its heat from contact with the cylinder walls, because it does its work so quickly. The engine easily admits of being compounded when an extremely high degree of economy is required. The engine has the advantage of being composed of a very small number of operative parts. The chief moving parts are, one piston, four partition blades, two valves, one crank disk, making eight in all. Only one adjustment is necessary to take up wear, namely, the adjustment of the follower-pin 18. All moving parts are immersed in steam and are self-lubricating, which greatly reduces the amount of oil required. The crank pin and shaft journals have roller bearings, as seen in Figs. 1 and 2. All the moving parts are enclosed and kept free from dust except the shaft. The extreme lightness of the engine prevents vibration and permits its use on upper floors with safety. The engine readily admits of reversing mechanism. This type of engine is particularly applicable for all uses where a very high speed is required, as in launches and other steam vessels, driving of dynamo electric machines or the operating of fans, hoists, blowers, etc. The engine is manufactured by the American Engine Company, of Bound Brook, N. J.



A Longitudinal Sectional View, showing Interior Construction of the American High Speed Engine.

FIG. 2.

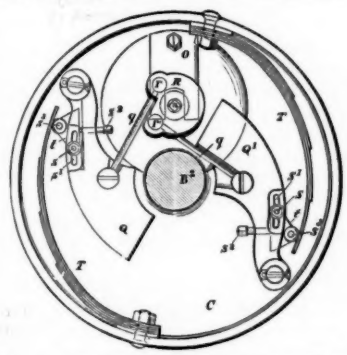
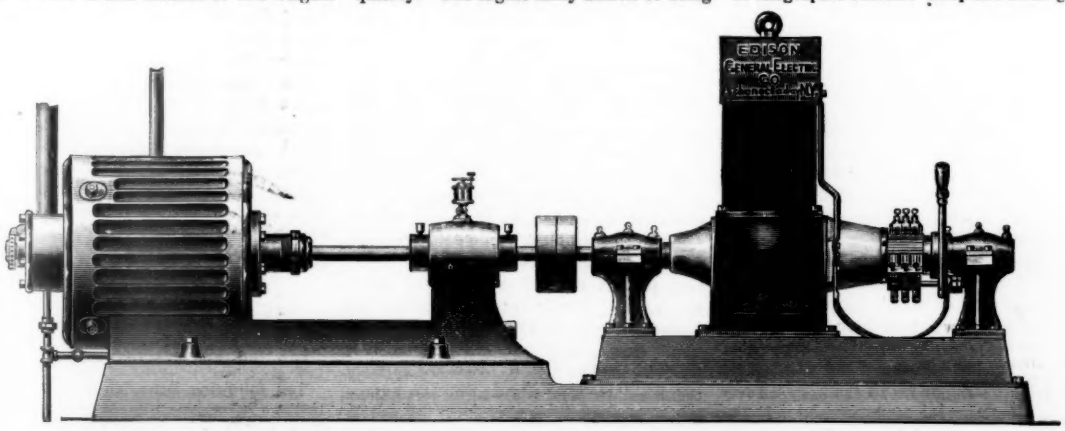


FIG. 3.—GOVERNOR OF AMERICAN HIGH SPEED ENGINE.



American High Speed Engine as Coupled Directly to an Edison Dynamo.

FIG. 4.

The Western Union Operating Outfit.

By special invitation of Gen. T. T. Eckert, the new operating rooms of the Western Union Company, at 195 Broadway, were thrown open to the inspection of the members of the American Institute of Electrical Engineers and of the New York Electrical Society, on Wednesday evening, February 17. The electricians were out in force to avail themselves of so fine an opportunity to criticise the finest telegraph equipment in the United States. Messrs. A. S. Brown and Robert Morris, of the Western Union, kindly escorted the members through the building and showed the points of greatest interest. The new switchboards are patterns of workmanship and convenience. One feature of special interest was a bank of incandescent lamps over each switchboard. The lamps are used as resistance for the lines and vary in resistance, so that by interposing a particular lamp in circuit the line may be put in the best electrical condition. The lamps in case of an accidental ground become incandescent, thus giving ocular evidence of the deficit on the lines. A noticeable feature of the equipment was the extent to which dynamo-electric machines are being used to supplant batteries and sources of telegraphic current. Loop and small generators are employed, the former being used at line terminals and the latter at intermediate points to strengthen the line current. The automatic and printing instruments were put in position for the benefit of the guests. The pleasure taken in the evening's entertainment showed from the faces of the visitors, and endorsed the sincerity of the vote of thanks rendered to the officers of the Western Union for the delicate attention they had paid the societies.

Roseburg, Ore.—Roseburg Electric Light Company; capital, $20,000. Promoters, J. E. Hurd, O. Boon, L. L. Hurd. Incorporation papers sent to L. L. Hurd, Roseburg, Ore.

Seattle, Wash.—Duwamish Construction Company; capital, $200,000. Promoters, John S. Patterson, A. Mackintosh, Hugh L. Thomas. Incorporation papers sent to Hugh L. Thomas, Seattle, Wash.

Jacksonville, Fla.—Oak Terrace Cold Storage Company; capital, $25,000. Promoters, T. H. Butler, J. M. Foggerty, W. T. Chapin. Incorporation papers sent to T. H. Butler, Jacksonville, Fla.

Marseilles, Ill.—The Marseilles Electric Light and Power Company; capital, $25,000. Promoters, Clarence Griggs, C. L. Stinson, J. M. Grantham. Incorporation papers sent to Clarence Griggs, Ottawa, Ill.

New Orleans, La.—Canton Water Works and Electric Light Company; capital, $50,000. Promoters, Irwin Jamison, L. E. Cenas, Relant C. Perkins, all of New Orleans. Incorporation papers sent to Irwin Jamison, New Orleans, La.

Brooklyn, N. Y.—The Curtis Electric Company, incorporated in West Virginia; capital, $500,000. Promoters, Byron A. Beal, W. W. Pratt, F. B. Hooper, all of Brooklyn, N. Y. Incorporation papers sent to James C. Foley, 206 Broadway, City.

Santa Rosa, Cal.—Merchants' Lighting Company; capital, $50,000. Promoters, J. H. Bruch, M. H. Dignan, Wm. E. Stahl, I. A. Proctor, T. P. Keegan, J. H. Einhorn, C. A. Wright, all of Santa Rosa, Cal. Incorporation papers sent to T. P. Keegan, Santa Rosa, Cal.

Hollister, Cal.—Hollister Light and Power Company; capital, $25,000. Promoters, Thomas Donovan, E. A. Crepin, of Hollister, Cal.; F. E. Kenney, Wm. Palentag, A. Towne, Thomas McMahon, G. S. Nash, all of San Francisco, Cal. Incorporation papers sent to Scott & Dooling, Hollister, Cal.

Missouri and Kansas Telephone Company.

President J. R. Mulvane has issued the following circular to the stockholders of the Missouri and Kansas Telephone Company:

Your company's gross earnings for the year are, $436,572.00, a decrease from 1890 of $4,600.23; gross expenses, $330,024.27, an increase from 1890 of $16,147.46; of which $48,683.16 was paid in dividends, leaving a balance of $57,864,57; of which the sum of $20,770.58 was put in new plant, leaving a balance of $37,093.99; of which the sum of $15,000 was paid on your new building, leaving a surplus of $22,093.

Much of the increased expense is increased cost of maintenance. Since the great loss in the sleet-storm of Christmas day, 1888, the policy of building up an available cash reserve has been adhered to, that we might meet the demands of an emergency, and the demands for underground plant and new exchange at Kansas City, Mo., which will call for an expenditure estimated at $250,000.

Your company was compelled to buy a building for permanent headquarters, as we could not build an expensive exchange in rented property, a removal being impossible, hence the purchase of the Security Building, northwest corner of Sixth and Wyandotte streets, was consummated by your directory at a great bargain, at the sum of $100,000, on which cash payment has been made of $15,000; assumption of existing debt due in five years at five per cent., $25,000; $15,000 due in the same time at five and three-tenths; our paper for $45,000 due at our option after five years to 12 at six per cent.

The condition of your company has been materially improved from year to year, until we think it will compare with the best in the country; and that the large expenditures must, in the near future, lessen the maintenance charge.

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Address all communications and make all money orders and checks payable to order of ELECTRICAL REVIEW, P. O. Box 3329, New York.

No attention will be paid to communications for the REVIEW without the *name and address of the writer*.

NEW YORK, MAR. 5, 1892.

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President Huntley has cause to feel well satisfied with the results of his year's work for the National Electric Light Association. None could have done better, and he retires with a hearty commendation from all.

The staff of the ELECTRICAL REVIEW deeply appreciates the many scores of letters of congratulation and kind words from brother editors on the Decennial Number of this journal that have been received.

It is a happy feature of newspaper work in this field that the electrical workers take so much interest in our labors to keep our columns abreast with the times, ever ready to commend what they believe to be progressive, and not slow in criticising that which does not meet their views.

It is a pleasure to look back over the past and note the cordial spirit of co-operation which, born of opposition and fostered by the mighty struggle for recognition, has ever existed between the promoters and toilers in the electrical arts and the men of the electrical press. To this hearty and mutual goodwill and to the encouragement which it engendered, may be attributed much of the marvelous success which has attended the introduction of all that is good in the application of electricity to practical uses.

We desire to thank our friends for their kindly words of commendation, and to assure them of a continuance of that policy which has so long had their approval.

There is quite a boom in submarine cable projects at the present time, and a very large number of important cable lines are to be laid in the near future. This line of investment has always proved a remunerative one, and the increasing commerce of the world, due to the opening up of new fields, has made a demand for better facilities of communication. The islands adjacent to our coasts whose trade with the mainland is becoming more and more important, have several schemes in hand for connecting the more important ports with each other and with a convenient point of the adjacent shores.

Among the books we have recently received are the "Journal of the United States Artillery," published by the authority of the staff of the artillery school, for January, 1892. It is the first issue of this journal, which will, for the present, be issued quarterly, and is temporarily under the editorial management of a committee of five designated by the staff of the artillery school. It is well edited, and we trust will realize all the hopes that are entertained for its success; "Reports from the Consuls of the United States" for October and November, 1891; and a most interesting history of the West End Street Railway, of Boston. In the latter is a large mass of valuable historical matter.

ELECTRIC HEATING.

Heating by electricity is now attracting great attention in the commercial world, due in part to the successful record which has lately been made in street car work, but more particularly to the large increase in the possibilities of obtaining current near at hand at a reasonable figure.

Further than this, the recent great strides made in the industrial transmission of power from a cheap source has opened up a very wide field for this branch of the electric arts as it has in many others. The Electric Merchandise Company, of Chicago, Illinois, the agents for the Burton electric heaters, are now making special and successful efforts to cover this enlarged field to its full limits and we may expect to see at a not distant date a very much more extended application of electric heaters to all purposes of domestic and public use.

The advantages of this method of heating are too obvious to require mention and had it not been for the excessive cost of current which has so long prevailed, heating by electricity would much sooner have reached the point where it stands to-day with its flattering outlook for the future.

THE COMBINATION.

The Edison-Thomson-Houston combination will make a very powerful element in the patent field, and there is much speculation just now as to what policy will be pursued in the dealing with infringing manufacturers and users. Should the recent decision of Judge Wallace in the Edison lamp suit be sustained by the court of last resort, as many well informed patent lawyers predict, will the Edison Company undertake the sole manufacture of incandescent lamps in this country, or will it license infringing manufacturers? Then again, the Edison Company own the three-wire system of electric distribution, and the Thomson-Houston Company control the storage battery and double carbon arc lamp patents. These four patents alone of many others which are almost fundamental, place an immense power in the hands of this combination. How this power will be used it is hard to predict, but it seems not unlikely that it will be used as a lever to force those larger companies, outside of its control at present, to a harmony of action or a consolidation, as may seem best to its future interests. We do not believe, however, that arbitrary methods will be pursued, nor that unreasonable terms will be demanded, for this would be a policy that would surely overshoot the mark, but we should not be greatly surprised soon to see the electrical business of the country under the control of one authority, carried on upon a clearly settled policy, and selling at prices certainly no higher than those at present generally ruling.

THE BUFFALO CONVENTION.

The National Electric Light Association has again shown to the electrical world its vast power for good in the collection and dissemination of knowledge upon the live, practical subjects upon which every central station man, every electrical engineer and every worker in this particular field, wants information.

The Buffalo Convention was in every way a most successful meeting and great credit is due to those who directed the affair for the business-like manner in which plans were laid and carried out. The papers read were upon most interesting topics, and with such speakers as Thomson, Stanley, Gray, Stillwell, Hering, Peck, Leonard, and the other stars of this bright galaxy, it is needless to say that they were well handled.

The discussions that followed were of the utmost importance and were entered into in an enthusiastic spirit, bringing out a very full consideration of the topic in hand. The banquet tendered the Association by the citizens of Buffalo was a most enjoyable affair and cemented the very friendly spirit which was already engendered by the cordial nature of the reception by the Buffalonians. The trip to the Niagara tunnel proved a very instructive feature of the meeting and a revelation to many who had not realized the immensity of the undertaking or the vast strides being made in the field of power transmission.

President Huntley retires after a year of most successful administration with the Association never in a more flourishing condition financially and as regards membership, for many new names have been recently added to the rolls. In the selection of Mr. J. I. Ayer, of St. Louis, as the new president, the Association placed itself under the leadership of an able, earnest and progressive man, who will not fail, assisted by the co-operation of such worthy vice-presidents as Judge Armstrong and C. H. Wilmerding, and the enthusiastic members of the Executive Committee, to direct its affairs under a vigorous and well defined policy, tending to raise this body to that position to which it is entitled from the important character of its work. We congratulate the Association and predict an excellent record for 1892-3.

THE PROPOSED PACIFIC CABLE.

Regarding the report that the British government would contribute towards the cost of a submarine cable from Vancouver to Japan, word comes from Montreal that Mr. C. R. Hosmer, of the Canadian Pacific Telegraphic Company, said that the Canadian Pacific Railway Company is very desirous of seeing a cable laid between the places mentioned, as the existing cable rates of $2.21 and $2.86 per word greatly restrict business and are practically prohibitory. They are satisfied that a cheaper and quicker means of communication between Canada and the United States and China and Japan would greatly stimulate business between these countries, which even now is showing rapid strides. Mr. Hosmer continued:

"We have examined the question very closely to see what would be the most available route, and it will be some time yet before a sufficiently comprehensive scheme can be shaped to warrant the company in endeavoring to carry it out. The cost of such a cable would be between $4,000,000 and $5,000,000, and the route would most probably be from Vancouver *via* the Aleutian Islands."

ARE ADVERTISEMENTS READ?

FAVORABLE TESTIMONY OF ONE OF THE BUSIEST MEN OF THE DAY.

The following letter is one in which the REVIEW takes just pride, coming as it does from a gentleman whose every moment is occupied with affairs of weight and consequence:

TO THE EDITOR OF ELECTRICAL REVIEW:

I thank you very much, indeed, for sending me an early copy of the Decennial Number of the ELECTRICAL REVIEW. It indicates an amount of enterprise and skill which is extremely satisfactory. I hope the number will have a wide distribution. I am wonderfully interested in the advertisements it contains, and watch them with great interest, as they show such activity and energy in this great business of electricity as to almost make one rub one's eyes to see such progress.

Faithfully yours,
ERASTUS WIMAN.

314 Broadway, N.Y., Feb'y 20, 1892.

Protection of Secret Processes.

A case of considerable interest to manufacturers and their employés seems likely to be that in which a Rochester firm of photographic supply manufacturers seeks to prevent ex-employés from forming a company to go into a similar business of manufacturing, on the ground that they propose to use in the interest of the new company information regarding secret processes which is not rightfully their property, and that the formation of the new company amounts to a conspiracy against the business interests of the older company. A temporary injunction has, we understand, been granted. Of course, we are not sure that all the circumstances that should be taken into consideration have been given in the published reports, but it does not seem to us probable that a permanent injunction will be granted in any such case. The government offers in the patent office such security as it seems practicable to give for trade secrets, and if such a principle as seems to be involved in this case were sustained by the courts and carried to its logical conclusion, it would probably prove to be one of the greatest obstacles to industrial progress and development that has ever been devised. A man's experience gained in his daily work is one of the things which he works for, and which makes his services valuable both to himself and to others. If he could be effectually prevented from making any use of this experience or knowledge, except in the service of the employer in whose establishment it was gained, that would not only be a bad thing for the man, but it would be a very bad thing for the people generally, for there could be very little progress and very little incentive to profit by experience or to improve by it. Under such conditions, workmen would take employment understanding that any additional knowledge or experience gained by them would be available only while working for the same employer, and the employer, also knowing this, would, of couse, refuse to consider the question of increased pay, because he would have a practical monopoly of the services of the employee, and could retain his services practically upon his own terms.

Of course, it will seem to a manufacturer to be unjust that new processes of special value originated or developed in his establishment may become public property and be used by his competitors; but if the courts could and did effectually prevent all apparent injustice of that kind, the diffusion and development of technical knowledge would be completely arrested. Nearly all processes which are of any value are patentable, and the government will protect the inventor in the exclusive use of them for a definite term of years, on condition that he fully reveals and explains them in such a manner that at the expiration of the term of the patent, any one who desires may make use of them. It is not at all likely that the courts will grant perpetual protection in the exclusive use of such processes without any conditions whatever.—*American Machinist.*

Funeral of Mr. George Worthington.

The funeral ceremonies over the remains of Mr. George Worthington, former editor of the REVIEW, were held at Buffalo, Thursday afternoon of last week. Relatives and friends, of Buffalo, were in attendance. Mr. Charles W. Price and Mr. Cyrus O. Baker, Jr., of New York, and Mr. Fred. W. Royce, of Washington, were also present. The body was taken to East Bethany, N. Y., for interment.

The Brooklyn Railway Contract.

It is reported from Lynn, Mass., that the Thomson-Houston Electric Company has secured the contract for the equipment of the Brooklyn City Railway with electric power. The company owns and controls nearly twice as many miles of road as does the West End of Boston. The contract is variously estimated at from $3,500,000 to $5,000,000, probably nearer the latter figure. Besides this large contract the Thomson-Houston has recently closed several minor ones aggregating nearly $1,000,000.

THE DECENNIAL NUMBER OF THE "ELECTRICAL REVIEW."

"A JOURNAL OF WHICH THE WHOLE ELECTRICAL FRATERNITY MAY WELL FEEL PROUD."

[*Standard-Union, Brooklyn, N. Y.*]

The decennial number of the ELECTRICAL REVIEW, just out, is a work of art. It is beautifully printed and magnificently illustrated. Its hundred broad pages are crowded with interesting matter pertaining to electrical science. It is a journal of which the whole electrical fraternity may well feel proud, and that it is a great business success is evidenced by the mass of advertising patronage with which it is favored. The ELECTRICAL REVIEW is published at No. 13 Park Row, and is edited by Mr. Charles W. Price, one of the brightest journalists of New York city.

"A MARVEL OF TECHNICAL JOURNALISM."

[*Howard in N. Y. Recorder.*]

The decennial number of the ELECTRICAL REVIEW, a souvenir of the recent Buffalo convention, is a marvel of technical journalism. Its review of electrical progress during the past ten years is a concrete history of the marvelous advances made by the science of electricity, interesting and instructive. The REVIEW is profusely and admirably illustrated with pictures of electrical men, electrical mechanisms and electrical curiosities, and its letter press, by distinguished writers, throws a flood of light upon an always attractive subject.

"MARVELOUS AS A REVIEW OF ELECTRICAL SCIENCE."

["*Ben Abou,*" *in New York Press.*]

The ELECTRICAL REVIEW, of which Mr. Charles W. Price is editor, has issued a Decennial Number in celebration of its tenth birthday which is marvelous as a review of electrical science and its development in the last decade. The growth of electrical inventions and the extension of the application of electricity is said to be only in its infancy. If it makes such strides in the next 10 years as is shown in this issue of the REVIEW to have made in the last 10 years it will eclipse even the imagination of men.

"OF MORE THAN ORDINARY MERIT."

[*Philadelphia Ledger.*]

The ELECTRICAL REVIEW, published at 13 Park Row, New York, celebrates its tenth anniversary by issuing a very handsome Decennial Number, dated February 20, 1892. This issue contains a large number of very handsome illustrations and numerous special articles of more than ordinary merit. A history of electrical progress for the past 10 years is an important feature.

"IS OF THE GREATEST INTEREST."

[*Reading, Pa., Herald.*]

The Decennial Number of the ELECTRICAL REVIEW, published at 13 Park Row, New York, has just been issued. It is partially a souvenir of the Fifteenth Convention of the National Electric Light Association, which is holding its meeting at Buffalo, N. Y., and partially a review of the electric progress of the past 10 years. The number is of the greatest interest, not only to the electrician, but also to the general reader as an illustration of the marvelous progress of the last decade in the adaptation of the electric current to the uses of man.

When the REVIEW began its career 10 years ago, the commercial aspect of electricity was very doubtful. The electric light was little more than an experiment, electric cars were talked of and the thousand and one uses to which the current has since been put existed only in the dreams of inventors, but now every line and page, both of the advertisements and reading matter, of this scientific magazine teems with evidences of the great commercial success of electric devices in every activity of life, while the hundreds of millions of invested capital attest the faith which money has in the business. In addition to the many interesting editorial articles and the general review of the progress of the science, the Decennial Number contains special articles on various branches of applied electricity from such eminent lights in electric science as John A. Barrett, George C. Maynard, Frank A. Perret, William Bracken, George A. Hamilton and J. J. Carty.

This issue of the REVIEW is in itself a shining example of the present importance of the electric business, since it makes quite a fat volume crowded with scores of pages of advertisements, which must send a very heavy and delightful current of dollars into the pockets of its proprietors.

"AN ENTERPRISING CHAMPION."

[*New York Journal of Finance.*]

The Decennial Number of the illustrated ELECTRICAL REVIEW is also a souvenir edition of the Fifteenth Convention of the National Electric Light Association meeting at Buffalo.

The development of the REVIEW has been coincident with that of the electrical field, as the journal was started at a time when matters electrical were in a rather chaotic and undeveloped state, and there is no doubt that it has been of great material benefit. Electrical interests are to be congratulated on having such an enterprising champion.

"ALL OF WHICH IT SAW AND PART OF WHICH IT WAS."

[*Troy, N. Y.. Times.*]

We are living in an electric age, and nothing is more wonderful than the development of electrical science. On the fourth page of to-day's Troy *Times* is a concise summary of electrical progress during the past 10 years. It is a synopsis of facts presented by the ELECTRICAL REVIEW, one of the leading technical journals of the country. The REVIEW itself is but 10 years old, so the chapter of history that it furnishes relates to occurrences "all of which it saw and part of which it was."

"PARTICULARLY WORTHY OF ATTENTION."

[*Engineering and Mining Journal.*]

The ELECTRICAL REVIEW, of New York, has, with its last issue, completed a life of 10 years. The Decennial Number, celebrating this event, is an interesting edition, having a cover artistic in design and containing in its 90 pages much of interest to those engaged in electrical pursuits. The article entitled "Electrical Footprints of a Decade" is particularly worthy of attention.

"BEST AND HANDSOMEST PUBLICATION."

[*Cincinnati Commercial Gazette.*]

What is far and away the best and handsomest electrical publication ever issued is the Decennial Number of the ELECTRICAL REVIEW, of New York, which has just reached us. The REVIEW celebrates its tenth birthday by issuing this 100-page magazine, which contains a large number of meritorious special articles and handsome illustrations. The electrical progress of a decade is covered in such a way that the general lay reader will enjoy it as well as the electrician. Mr. Stephen L. Coles, one of the associate editors of the REVIEW, is a Cincinnati man, scarcely 24, but possessing distinct journalistic capacity. This number of the REVIEW gives one a graphic idea of the growth and importance of class journals.

"WILL REPAY PERUSAL."

[*New York Mail and Express.*]

The decennial number of the ELECTRICAL REVIEW is, perhaps, the best newspaper of the kind ever printed. It is filled with the most interesting matter about electrical subjects, and will repay perusal by any one interested in the progress of the work.

"BY LONG ODDS THE MOST POPULAR."

[*Philadelphia Evening Item.*]

There is no greater evidence of the growing prosperity of a trade or profession than the fact that some enterprising person finds a hole into which a journalistic peg fits to advocate its advancement or call attention to its benefits.

A decade ago, when the ELECTRICAL REVIEW was started, the particular science which it advocates was in its infancy. Since then it has grown into a vigorous youth, with the prospect of accomplishing wonders by the time it enters into manhood's estate.

That it has kept even pace with the times is evidenced in the fact of its present prosperity.

From a little 16 page, three column sheet, without a cover, a decade ago, it has grown into an 88 page, four column sheet, with an expensive and artistic cover fully one-third larger in size.

Then, there were two pages of advertisements, now there are 56 pages so employed, besides three pages of the cover. It bears the reputation of being the largest, the most exhaustive, and by long odds the most popular weekly journal devoted to the advancement of electric interests.

As it is the pioneer in the field its success and popularity are well deserved. The reading matter in the current number covers a number of very interesting subjects based upon electricity, and furnishes food for the student in every branch of the science.

The intelligence which Editor Charles W. Price has brought to bear upon the subject has made the ELECTRICAL REVIEW an authority upon all matters pertaining to the sciences which have electricity for their foundation. Mr. Price is vigorous, progressive and brilliant, and fills the position with honor to himself and his paper.

A SOUVENIR OF BUFFALO.

[*Buffalo Commercial.*]

The ELECTRICAL REVIEW, of New York, which was the first electrical weekly published in this country, celebrates the fifteenth convention and its tenth birthday by issuing a superb decennial number, which is of especial interest to Buffalonians. A beautiful design printed in colors appears on the cover. The Library Building and Soldiers' Monument are artistically pictured in this design. Considerable space and a number of very fine illustrations are devoted to Buffalo and her industries.

It also contains excellent cuts of Mayor Bishop, John N. Scatcherd and other leading citizens. A fine view of Main street is a very attractive illustration. Buffalo is highly spoken of in a leading article.

The REVIEW is represented here by Editor Price, Associate Editor Coles and Manager Richards. Mr. Price is secretary of the International League of Press Clubs and is widely known.

The publishers claim that this is the finest electrical publication ever issued.

The ELECTRICAL REVIEW has reserved the large parlor at the Hotel Iroquois as headquarters, and the business men of Buffalo will be welcome callers.

"ELECTRICAL JOURNALISM—ITS GROWTH IN A DECADE AS EXEMPLIFIED IN THE 'ELECTRICAL REVIEW.'"

[*Boston Herald.*]

Journalism that is based upon industrial or other forms of human progress, if truly representative, shows a close relation in its development to that of which it is representative. This is exemplified in a most remarkable manner in electrical journalism, which, in sympathy with the thing it represents, shows a rapid and surprising degree of development, giving us to-day representative papers which are first-class in every respect, from typographical execution up to their literary and scientific make-up, and giving the most unmistakable evidences of business success in the extent and nature of their advertising patronage.

This reflection has been called forth by receipt of the Decennial Number of the illustrated ELECTRICAL REVIEW, of New York, of February 20, which, in addition to the object of marking an epoch in the history of that paper, is intended as a souvenir of the Fifteenth Convention of the National Electric Light Association, at Buffalo, N. Y. This is an unusually interesting number of this successful journal, filled as it is with the most valuable and interesting matter pertaining to the history of electricity. Its prominent feature is comprised in the general subject of "Electrical Footprints of a Decade," and embraces "Electrical Men and their Work," "Electric Light and Electric Power," "The National Electric Light Association" and "Buffalo, Electrically and Industrially," all finely illustrated. Among the notable essays in the REVIEW are: "Ten Years with the Telephone," by John A. Barrett; "The Telegraph in America," by George C. Maynard; "Development of the Electric Motor," by Frank A. Perret; "The Storage Battery," by Wm. Bracken; "The Telegraph and Telephone," by George A. Hamilton; "Is Electricity Related to Nervous Force?" by J. J. Carty; "Progress of Ten Years of Electricity," etc., etc.

As the ELECTRICAL REVIEW truly says: "The history of the REVIEW is practically a history of electricity; aside from the telegraph, all of the great industrial electrical improvements have had their development during its life. It has told in its pages an interesting story of electrical progress. It has witnessed the growth of the telephone, the electric light and the electric railroads. * * * It has recorded the 10,000 and more inventions which have contributed to the great progress of the art."

And all this in 10 years. Verily, in the line of electrical development, we are making history rapidly in these days.

"REFLECTS GREAT CREDIT ON THE ENTERPRISING PUBLISHERS."

[*New York Tribune.*]

The Decennial Number of the ELECTRICAL REVIEW, of this city, just issued, reflects credit on the enterprising publishers, both in its typography and contents. There are articles on the "Telegraph in America," by George C. Maynard; "Telegraphic Shorthand," by John P. Gavit; "Possibilities of Electric Traction," by John W. Beane, and "Is Electricity Related to Nervous Force?" by J. J. Carty, which give an excellent idea of some of the more recent developments of electric science.

LETTERS WORTH READING.

SUBSCRIBERS OF THIS JOURNAL WHO ARE PLEASED WITH THE DECENNIAL NUMBER AND STOP LONG ENOUGH TO SAY SO.

FROM MR. EDISON.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—Permit me to congratulate the REVIEW upon attaining its tenth birthday. The special number issued to celebrate that event is a credit to all concerned in its production, and is away ahead of anything before published by the electrical press.

With best wishes for future prosperity, believe me, Yours sincerely,

THOMAS A. EDISON.

Orange, N. J., February 26.

FROM MR. WESTINGHOUSE.

TO THE EDITOR OF ELECTRICAL REVIEW:

Dear Sir—I am in receipt of the Decennial Number of the ELECTRICAL REVIEW, for which please accept thanks. You seem to have spared no pains to make this number especially attractive to your readers. Truly yours,

GEORGE WESTINGHOUSE, JR.

Pittsburgh, February 22, 1892.

FROM MR. W. A. STADELMAN.

TO THE EDITOR OF ELECTRICAL REVIEW:

Dear Sir—You have certainly done it this time. Your Decennial Number just received is certainly *by far* the handsomest thing in the line of electrical papers that I ever saw.

Mrs. Stadelman (who always reads the REVIEW) and I have been admiring it all evening. You are certainly to be congratulated.

Very truly yours,

W. A. STADELMAN.

Philadelphia, Feb. 22, 1892.

FROM CAPT. GEORGE N. STONE.

TO THE EDITOR OF ELECTRICAL REVIEW:

Dear Sir—I beg to acknowledge with thanks the receipt of a copy of the Decennial Number of your great conductor of reliable electrical information, which is indispensable to all parties interested in electrical enterprises. With best wishes for your continued success, I am very respectfully,

Cincinnati, Feb. 23, 1892. G. N. STONE.

FROM MR. CHAS. E. DUSTIN.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—I have your Decennial Number and am very much pleased with its appearance. It is certainly very handsome. Yours very truly,

Middletown, Conn., Feb. 24. C. E. DUSTIN.

FROM MR. CHAS. H. WILSON.

TO THE EDITOR OF ELECTRICAL REVIEW:

Dear Sir—I take pleasure in acknowledging the receipt of the Decennial copy of the ELECTRICAL REVIEW. It is certainly an admirable piece of work, both as regards the character of its contents and the artistic manner in which it is produced.

Very truly yours,

Chicago, Feb. 22, 1892. C. H. WILSON.

FROM DR. S. S. WHEELER.

TO THE EDITOR OF ELECTRICAL REVIEW:

Dear Sir—I have received your very handsome Decennial Number and am greatly pleased with it. I consider it the first really artistic piece of work in electrical journalism. Very truly yours,

S. S. WHEELER.

New York, February 27, 1892.

FROM MR. SAMUEL INSULL.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—I received a copy of your Decennial Number and read the same with very great pleasure. It is a very fine specimen of newspaper work, and in every way creditable to the occasion.

Wishing you and your paper every success in the future, I remain, Yours very sincerely,

SAMUEL INSULL.

New York, February 23, 1892.

FROM MR. W. W. SMITH.

TO THE EDITOR OF ELECTRICAL REVIEW:

My Dear Sir—Your Decennial Number arrived today, and has been perused with much pleasure; indicating, as it does, the success which deservedly belongs to your efforts.

I have been a subscriber from the beginning, and expect to be until Gabriel sounds his horn.

Yours very truly,

W. W. SMITH.

Kansas City, Mo., February 23, 1892.

FROM PROF. BELL'S OFFICE.

TO THE EDITOR OF ELECTRICAL REVIEW:

Dear Sir—I beg to say that Dr. A. G. Bell and his secretary are both abroad at present, but expect to return early next month.

Allow me to deservedly compliment you on your Decennial Number; it is perfect. For instance, Dr. Bell's portrait is the best reproduction I have seen, and if you could have a dozen copies of this portrait struck off on separate sheets of the best of paper for the members of his immediate family, I should appreciate the favor and gladly pay the expense. Very truly,

JOHN HITZ, Supt.

Washington, D. C., February 22, 1892.

CORRESPONDENCE.

OUR LONDON LETTER.

The Sims-Edison Torpedo.—At Portsmouth, the beginning of the week, took place the first public trial in England of the Sims Edison electrical torpedo. The actual torpedo used for the demonstration is four years old, and has already been on exhibition in the United States and in France. The important feature of the trial, and one which had never before been attempted, was that the Sims-Edison torpedo was to be discharged, actuated and controlled from a vessel under way. Mr. Sims, the inventor, explained the mechanism of dropping and working to the visitors who were brought by steamer from Portsmouth to the tug in Stokes Bay. He showed the temporary conning tower in which in compact form are the electrical instruments for controlling the speed and direction of the torpedo, and for firing it when arrived at its destination. The tug was then moved slowly ahead and the torpedo dropped from the davit and, soon gathering way, darted ahead at a speed of about 17 knots an hour. It was permitted to make a wide curve of about a mile and a quarter in length. Mr. Sims demonstrating his perfect control over the machine by turning to left or right at will. He was, however, unable to bring it back to the tug, having used up all the cable. A cable of smaller diameter had been ordered but not yet supplied, which accounted for the failure. The principle of the machine seemed perfect, but many improvements will need to be made before it can be turned to valuable account. The exposed position of the operator is, of course, one, and another is the likely source of accident in a wire connection fouling the screw of the ship. While, too, the government are naturally desirous of obtaining the most perfect system available, the superiority of the Sims-Edison torpedo over the Brennan would not appear to be sufficiently obvious to warrant the waste of the large sums paid for the latter.

Mr. Nikola Tesla's Lecture.—On the 3d inst., by permission of the managers of the Royal Institution, was given Mr. Tesla's lecture on "Experiments with Alternate Currents of High Potential and High Frequency." The details of his various experiments had reached us from the other side of the Atlantic, but all the foremost electrical authorities of the day were anxious to witness for themselves the practical application of his researches. For two full hours Mr. Tesla kept his audience spellbound, and one found it hard to believe that the lecturer had but once before delivered a lecture in public. At the end he informed his listeners he had shown but one-third of what he was prepared to do. And then the audience, even after Professor Ayrton had declared the meeting at an end, remained in their seats eager for more, and only satisfied when Mr. Tesla had been induced to deliver a supplementary lecture. Mr. Tesla stated that practically the whole of his experiments were new and not a mere repetition of his lecture in America. The bringing filaments to incandescence on a single wire and the lighting of tubes in an electrostatic field, had, of course, been shown before, but being of the most importance they were naturally shown again. Among the probabilities the lecturer hinted at were the illumination of houses without wires, the transmission of light and power to a distance without wires, the synchronizing of wave lengths for multiplex telegraphy without wires, the use of motors with but one wire, and possibly even without any at all.

It would be absurd for us to endeavor to give you any details, as a full and illustrated report, revised by Mr. Tesla himself, is being prepared for the Journal of the Institution of Electrical Engineers, and will contain much that could only be glanced at in the lecture itself.

Mr. Tesla in Paris.—Mr. Nikola Tesla was announced to deliver a lecture yesterday to the Société Française de Physique and the Société Internationale des Electricians, at the hall of the Société d'Encouragement, 44 Rue des Rennes, Paris. CHAS. FFRENCH.

London, February 10.

OUR SEATTLE LETTER.

The 337 Electric Lights in Tacoma cost $4,044 a month.

The Great Northern's telegraph line between Seattle and New Westminster is now open for business in charge of F. M. Overbeck.

Theodore Hosmer, president of the Tacoma Light and Water Company, has secured control of the Commercial Electric Light Company.

Walter Harris, an electrician, who worked for the Thomson-Houston Company here, has suddenly disappeared, leaving his wife and baby without means of support.

The Seattle Gas, Electric Light and Motor Company has failed to get a new trial for its suit for $100,000 damages against the city for a change of grade. The company lost.

The Snohomish, Skykomish, and Stillaquamish Telegraph Line, better known as the "Three S," has opened for business. It connects at Snohomish with the Pacific Postal, though the latter does not control it.

The Seattle Consolidated Street Railway Company has elected the following board of trustees: L. H. Griffith, D. T. Denny, Geo. R. Kinnear, J. E. Porter, J. F. Hale and Victor Hugo Smith.

The Green Lake Electric Railway Company has leased its line and cars to the Seattle Consolidated Street Railway Company for two years from February 15, together with an option of purchase of the entire line and its equipment running for two years.

The Jury in the case of J. W. Hunt *vs.* the Seattle Consolidated Street Railway Company, brought in a verdict for plaintiff awarding him a judgment of $600. Hunt sued the company for $10,000 damages sustained by being thrown off a car. The award was apparently a disappointment to both sides, for Hunt's motion for a new trial was at once assented to by the defendant's attorney.

The Sunset Telephone and Telegraph Company will spend $160,000 on extensions in Washington this year. A new line will be built from Seattle to Snohomish and Everett, work to begin immediately. A new copper wire line will be built to Tacoma, and a line to Bellingham Bay is also contemplated. A line to Portland is also likely to be built, connecting with a number of small towns along the route. These extensions will enable people in Western Washington to converse from the British boundary to the Columbia River.

The Western Union and the Pacific Postal Telegraph Companies have gotten into a peculiar muddle in this State over the franchises along the railroad lines. When the latter company wanted to build from here to Portland a few years ago, it found the Western Union in control of an exclusive franchise along the Northern Pacific, which had the only road to Portland. After a long struggle the Pacific Postal put its wires just outside of the Northern Pacific's right of way. When the State constitution was formed, in 1889, the Postal company influenced the anti-monopolist element in the convention to insert a clause giving all telegraph companies equal rights along railroad lines, and the first legislature passed a law to enforce this provision.

It so happens that the Pacific Postal operates a line along the northern branch of the Seattle, Lake Shore & Eastern Railroad which runs to the Canadian boundary and connects with the Canadian Pacific. For this line the Postal company obtained an exclusive franchise; but the Western Union now proposes to parallel this. The Postal wishes to block this scheme but cannot do so without attacking a law passed in its own benefit, while the Western Union will be forced to defend legislation intended to destroy its monopoly on other lines. The Rocky Mountain Telegraph Line, which is a part of the Postal system, is now as far west as Missoula in Montana. The Postal company would like to extend to the coast, but the most direct line is by the Northern Pacific, where the Western Union has an exclusive franchise. If the Postal supports the exclusive franchise system on the Seattle, Lake Shore & Eastern, it must sacrifice its right to come across the State by the Northern Pacific route.

J. L. McDonnell, day chief operator in the Western Union Telegraph office at Tacoma, has developed a sextuple system of telegraphy and applied for a patent on it. He says that the battery required will cost less than one-twentieth of the first cost of that needed to work other systems of multiplex telegraphy. The new invention will work without repeaters, over great distances, Mr. McDonnell being confident it will work successfully over 3,000 miles of wire, which is equal to the distance between San Francisco and New York. On Sunday last he tested his system successfully over 800 miles of wire, by way of Portland, Pendleton, and Pasco. The wire was being used at the same time for way business. Mr. McDonnell says that after a few more experiments he will make public the principle of his invention, which is original. He is a native of Malone, N. Y., and this is his maiden invention, which the officials of the Western Union Telegraph Company, with whom he is now in correspondence for the lease or sale of his patent, say is very valuable and far ahead of any appliances for multiplex telegraphy now in use. H. L.

Seattle, Wash., February 15.

OUR BOSTON LETTER.

Mr. C. J. Mayer, general traveling agent of Messrs. R. D. Nuttall & Company, manufacturers of fine machinery and special tools, Allegheny, Pa., favored this office with a visit recently.

The Edison Electric Illuminating Company, of this city, with two large and perfectly equipped stations, operates, at the present date, 59,000 incandescent lights; and has more than 2,500 horse-power in motors on its circuit.

Mr. George W. Wilson, inventor and electrician with Wilson's Incandescent Light Company, has leased offices on the second floor of the Shoe and Leather Exchange Building, Nos. 114 and 116 Bedford street, this city.

The Worcester, Spencer and Leicester, Mass., Electric Railway accomplished a creditable performance with its electric car service recently. During the heavy snow storms which prevailed in this State the early part of the present month the company operated its eight electric cars over 14 miles of road without a delay exceeding ten minutes on any of the car trips. Four electric snow plows were kept in constant operation during fall of snow. From August 12, 1891, to February 1, the road is said to have carried over 5,000 passengers.

The Robinson Electric Truck and Supply Company, this city, is daily in receipt of large orders for its radial truck for electric car service, being evidence of the merits possessed by the truck referred to. The Union Street Railway Company, Providence, R. I., and the San Francisco, Cal., Street Railway Company have been supplied with several of the Robinson radial trucks since February 1. The West End Railway Company, of this city, has about 200 of the Robinson trucks on hand, 50 of which are in daily use on the electric cars in the streets of Boston. W. I. B.

Boston, February 27.

OUR ALBANY LETTER.

The Lines of the Watervliet Turnpike and Railroad Company have been leased to the Albany Railway Company. At a meeting of the directors of the former, January 11, it was decided that the interest of stockholders would be best subserved by a lease of the road and franchise to the Albany Railway, under an arrangement by which the Albany Railway shall guarantee the payment of the interest on the first mortgage bonds of the Watervliet Company, and the interest and principal of the second mortgage bonds of the company, and pay a rental which would represent a dividend of ½ of one per cent. upon the stock of that company. Now, every line of street cars in the city is controlled by the Albany Railway. A little less than three years ago, in March, 1889, the Watervliet Company improved its road and put in a complete electrical equipment at a heavy expense. The company issued consolidated mortgage bonds to the amount of $350,000, bearing interest at 6 per cent. and gave the contractors $155,000 worth of such bonds at par and 600 shares of the company's stock, on condition that the contractors lay new steel rails over 9¾ miles of the road and supply the company with 12 new 16-foot box cars electrical motor trucks and put up and complete an electrical system over the road, and to build a central power station and fully equip it with boilers, dynamos, etc. The contractors at the same time agreed to buy sufficient of the bonds at 95 to pay off the existing floating indebtedness, taxes, etc., up to July 1, 1889. It was expected that, upon the completion of the system the road should be capable of operating 14 cars at the average rate of 10 miles an hour. The road was opened with its new equipment in the fall of 1889, and since then has undergone some improvements and received additions to its rolling stock. With the change of management will come a general overhauling and extensive improvement that will make it practically a new road. The Albany Railway's present plant is one of the most complete and perfect of its kind in operation, and it is intended to extend all improvements to its newly acquired lines. The present power house on South Pearl street will be the central power station for the combined roads, the Broadway station to be held in reserve. The tracks of the Broadway line will be straightened and relaid with the heaviest grade of steel rails to facilitate speed and insure safety. Stations will be established along the Troy road and as soon as the city line is passed the motors will be run at their highest speed. The Albany Railway has ordered 10 extra long excursion cars, such as are used on the West End road in Boston, and will put them in service the coming Summer. The new acquisition nearly doubles the mileage of the Albany Railway's tracks. L. M. W.

Albany, February 27.

World's Electrical Congress.

TO THE EDITOR OF ELECTRICAL REVIEW:

It has been arranged by Mr. C. C. Bonney, president of the World's Congress Auxiliary, Mr. O. Chanute, chairman of the Engineering Congress Committee, and Mr. Elisha Gray, chairman of the Electrical Congress Committee, that the section of the Engineering Congress relating to electrical engineering shall be merged into the World's Electrical Congress. Due notice of this agreement from the office of the World's Congress Auxiliary will follow the recently distributed circular relating to the engineering congress. H. S. CARHART,

Secretary of the World's Electrical Congress Committee.

GENERAL NOTES.

Logan, O., wants electric lights.

Corry, Pa., has advertised for a street lighting plant.

Lansing, Mich., is talking about a municipal lighting plant.

Walkersville, Mont., is likely to have an electric street lighting plant soon.

Jonesboro, Ark., will soon be in the market for electric lighting for its streets.

Benton Harbor, Mich., is looking up the cost of electric light plants for street lighting.

John D. McLeod has been made general manager of the Wisconsin Telephone Company.

The Burlington road is experimenting with an electric motor for its suburban trains about Chicago.

Lebanon, Pa., is considering the advisability of erecting and operating an electric light plant of its own.

The Commercial Union Telegraph Company has completed arrangements for opening an office at Malone, N. Y.

The recent storms in Great Britain were so severe as to almost completely prostrate the land telegraph lines.

There is some talk of changing the passenger service motive power of the Pittsburgh and Castle Shannon Railway to electricity.

The Rochester Railway Company will equip all its lines with electric motor cars, so well are the officers pleased with the operation of those already so equipped.

The Edison General Electric Company is negotiating for a large building in Atlanta, Ga., which will be fitted up for the storage and sale of general electrical supplies.

One hundred and fifty district messenger boys struck the other day, because they were ordered in all cases to have their tickets signed and the amount paid entered on the same.

A judgement of $5,000 has been filed against the Norwich, N. Y., Electric Light Company, due to the financial embarrassment of Dudley Farlin, of Albany, president of the company.

The electric light business of Burlington, Vt., heretofore done by two companies, is now conducted by one corporation, under the name of the Consolidated Electric Company, with a capital stock of $150,000.

In connection with the new Otis Elevating Railway, which is now being built up the Catskill Mountain, it is said that an electric railroad from the upper terminus to Hunter, with a branch to Hotel Kaaterskill, is under consideration.

The steamer "Westmeath," which returned here recently after laying the Nassau-Jupiter cable, left port last week to pick up and repair the Mackay-Bennett cable, which lands at Coney Island, and which was damaged, with the Western Union cable, by the scows that went adrift two weeks ago.

A new line of telegraph is being built to be known as the South Florida Telegraph Company. It taps all points South and connects at Gainesville, Fla., with the International Ocean Telegraph Company and the line of the Savannah, Florida and Western line leading to Live Oak and Lake City, Fla.

There is a strong fight on between the Metropolitan Telephone and Telegraph Company, of New York city, and the Telephone Subscribers' Association, in the State Legislature, on the subject of telephone rates. The company propose increasing rates, so it is stated, to $240 per annum, this increase is largely due to the excessive tax of subway rentals.

"The Relation of Size and Efficiency in Transformers."

BY L. B. STILLWELL BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The designer of a transformer has presented to him alternative paths. He may easily design with reference to a very small loss of energy and relatively high efficiency at light loads, if he is willing to sacrifice regulation. He may design a transformer of little weight and large output, if he is content to work at a very high temperature, which may perhaps endanger the lasting qualities of his insulation. The best transformer is not necessarily that which has the lowest leakage or magnetizing current; nor that which regulates most closely; nor that which is lightest and most easily handled; nor yet that which will carry its full load indefinitely with the least increase of temperature, but it is that transformer which best combines as much of each of these desirable properties as is practicable. In comparing various types, therefore, it is necessary to begin with a realizing sense of the fact that the same laws govern all types as to design and performance, and that, under the general laws of physics which have to do with this class of work, extraordinary excellence in one respect is necessarily obtained at the price of sacrificing excellence with respect to other properties equally important.

Let us take, as a starting point, a very small transformer; for example, one of five lights capacity, the primary terminals of which are connected to an alternating current circuit of 1,000 volts potential. We will suppose that the lamps which are connected to the secondary circuit are all turned off. Under these conditions a small current, called magnetizing current, or leakage, flows in the primary coil. This current magnetizes the iron and, as a result, we have in the primary what is called a counter electromotive force. Every transformer, small as well as large, which is connected to this dynamo circuit, must develop a counter electromotive force approximately equal to that delivered to it from the dynamo. This counter electromotive force depends upon the alternating magnetization of a certain amount of iron, and the magnetization of this iron means the expenditure of energy. The amount of iron required and the expenditure of energy necessary will naturally be less in a transformer of small capacity than in one of large capacity, but there must be some iron magnetized and some energy expended in holding back the electromotive force of the dynamo. It is safe to say that a commercial transformer, by which I mean a transformer that can be manufactured at a cost that will make it a commercial or saleable article, cannot be so designed as to have a loss of less than 20 watts, due to the magnetization of the iron. A transformer twice as large—that is, of 10 lights capacity—is called upon to do precisely the same work and no more in developing counter electromotive force to oppose that of the dynamo and may quite as easily be designed to work with an iron loss of 25 watts. If the rated capacity of the five light transformer is 250 watts and of the 10 light transformer 500 watts, the loss in the former will be eight per cent. and in the latter five per cent. A 20 light transformer may as easily be designed to work with an iron loss of 30 watts, and a 40 light transformer with an iron loss of 45 watts; the percentage of loss in these cases being, respectively, three per cent. and 2.25 per cent.

One 10 light substituted for two five light transformers will reduce the amount of energy lost in magnetizing the iron from eight per cent. to five per cent.; a saving of three per cent. One 40 light substituted for two 20 light transformers will reduce iron loss from three per cent. to 2.5 per cent., a saving of one-half of one per cent. About the same percentage of saving can be effected by again doubling the size, and 100 light transformers can be furnished in which the iron loss does not exceed 1.7 per cent. Beyond this figure it is easily seen that improvement is difficult and even were it possible, by employing a very large transformer, say, one of 500 lights capacity, to reduce iron loss to one per cent., the improvement in efficiency resulting from the substitution of one of this size for five of the 100 light size would be but a fraction of one per cent., and, in view of the necessarily greater weight and the obvious objections to putting a large number of eggs in one basket, the advisability of such substitution would be doubtful.

Thus far we have considered only the loss in iron when no current flows in the secondary circuit, and it will be sufficiently accurate for our purpose to assume that this iron loss remains constant under varying loads of the transformer. The loss of energy due to the resistance of the copper when no current flows in the secondary is negligible, since the magnetizing current in the primary is very small, but this loss increases as the load on the transformer is increased, and the increase varies as the square of the current flowing; that is to say, the copper loss is four times as great when two amperes flow in the secondary circuit as when one ampere flows in that circuit. In the transformer without load we have a certain loss of energy designated iron loss, while in the transformer fully loaded we have this same iron loss plus the maximum copper loss. For intermediate loads we have approximately the same iron loss with varying copper losses dependent upon the amount of the load.

The loss due to the resistance of copper is generally about two per cent. This does not vary materially with a variation in size of the transformer, certain considerations having to do with regulation being largely accountable for this fact. If we assume that the loss in copper at full load for every size is two per cent., and that the iron loss is constant, irrespective of the load, the following table will, with sufficient accuracy, indicate iron and copper losses and efficiencies at full load. The table does not represent actual measurements of selected transformers, but is intended to fairly represent the proportionality of losses in transformers of various sizes. Actual tests will show results as good as or even better than the figures given in the table.

Capacity in 16 C. P. Lamps.	Loss in Iron. per cent.	Loss in Copper. per cent.	Efficiency at full load. per cent.
5	8	2	90
10	5	2	93
20	3	2	95
30	2.5	2	95.5
40	2.3	2	95.7
60	2.1	2	95.9
80	1.9	2	96.1
100	1.7	2	96.3
300	1.5	2	96.5

It will be seen that for sizes of less than 20 lights capacity the falling off in efficiency as we go down the scale of sizes is very rapid, while, on the other hand, the gain in efficiency of transformers larger than that of 20 lights capacity is much less marked. The exact significance of the table will, perhaps, be better shown by putting it in another form. Let us compare the losses at no load and at full load in 1,200 lights capacity of converters of each of the several sizes, and let us express the loss in each case in terms of the number of 16 candle-power lamps, which the energy so lost would be sufficient to supply. We then have the following:

Transformers used.		Loss at no load.	Loss at full load.
240	5 lt. cap.	96 lamps.	120 lamps.
120	10 "	60 "	80 "
60	20 "	36 "	60 "
40	30 "	30 "	54 "
30	40 "	$27\frac{6}{10}$ "	$51\frac{6}{10}$ "
20	60 "	$25\frac{8}{10}$ "	$49\frac{8}{10}$ "
15	80 "	$22\frac{8}{10}$ "	$46\frac{8}{10}$ "
12	100 "	$20\frac{4}{10}$ "	$44\frac{4}{10}$ "
4	300 "	18 "	42 "

These figures plainly show that to supply any number of lamps up to 100 it is desirable, on the score of efficiency, to use a single transformer of the required size rather than two or more of less capacity.

For sizes of a capacity above 100 lights the improvement in efficiency is necessarily little, and although the argument on the score of efficiency is still in favor of the use of the large sizes, that argument is by no means as strong as it was before we passed the 100 light limit.

This properly finishes the discussion on the relation of size and efficiency in transformers as they are to be purchased in the market to-day, but there are certain other considerations very closely connected with the subject which will naturally influence a central station manager. I have left myself no space for a discussion of these points, but they are, for the most part, of a very obvious character, and it will be sufficient to simply mention them.

In favor of the use of large sizes is the very practical argument of reduced cost per lamp capacity. In giving proper weight to this consideration the purchaser should assure himself that the manufacturer has not effected a reduction in cost at the price of an excessively high limiting temperature, which may endanger the lasting qualities of the insulation.

Transformers of 300 or 500 lights capacity are naturally large and difficult to handle; or if they are not very large it will be well to again note the temperature.

An investment in a 500 light transformer is large as compared with an investment in one of 100 lights capacity, and the chances of accident, such as may be caused by lightning, are quite as great in the case of the former as in the case of the latter.

It is extremely improbable that a static discharge from the line caused by lightning will damage more than one of a group of five transformers which may be connected together in multiple arc, while a discharge which may break down the insulation of one of these will be quite as likely to damage a 500 light transformer.

"The Allied Powers."

BY D. ASHWORTH, BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

At this period of the nineteenth century, by reason of the advance in an intellectual sense, such combinations are rare, and the signs of the times point to their entire extinction; but a greater and more powerful factor engrosses our attention, which, in the eternal fitness of things, can be called the Allied Powers—that is, the combination of steam and electricity. So powerful are they that I think we may be pardoned for the strength of our language in claiming that they are the foremost powers of all this world. Jointly, their application is universal; in the brilliant palaces of crowned heads, or illuminating the otherwise Plutonian darkness of the village bridge or chasm in the mountain, they emblazon with jewels of light the great city, at the same time cast a soft halo of light over the suburban town.

This subtle and all-powerful agent, electricity, this reinforcement and seemingly inseparable hand-maiden of the older agent, steam, will be left for those whose lines of thought and action have been concentrated thereon; those among you who have been and are continually developing its hitherto unknown resources and powers; to you is relegated the pleasant duty of presenting its claims to an enlightened and appreciative public, while we present to them the older one, that of steam and the steam engine.

Setting aside the many traditions and historical associations which have clustered about its early history, closing the eighteenth and commencing at the dawn of the nineteenth century, that close student and persistent Scotchman, James Watt, announced his patents.

As expressed by the historian, the advent of the steam engine gave that mighty impetus, which, contributed to by succeeding inventions, to which it was the prime mover, turned the people's thought from war to the fruitful vocations of peace.

There is a very notable feature in the development of the steam engine as relates to James Watt, to which I invite your attention, and that is that all the principal features so essential to economy of fuel, regulation and benefits to be obtained by expansion were fully considered by him. He was fully cognizant of the insidious losses by condensation, so that, after all, the marvelous progress that has been made in this direction has been in the refining of well-known existing conditions rather than the profundity of philosophical thought bestowed upon it by Watt in its early stages.

It is not our purpose to enter upon any description of the many devices which ingenious and fertile minds developed during these periods, but it is generally acknowledged that the drop cut off valve, invented by George Sickles, embracing as it does the tripper and dash-pot, giving an instantaneous cut-off, gave the keynote for further and more thorough steps in this direction. This was followed by the Corliss system of valve motions, producing results which attracted the attention of not only the engineering world, but the vast body of steam consumers. So thorough were the reforms of steam engineering, so complete were its results in economy and regulation, that the name and fame of Geo. H. Corliss is as familiar as a household word in all nations where the power of steam is used, making an epoch in our country's history which, as a grateful people, as well as engineers, we should cherish with pride and patriotism.

We now come to the period where the merging of the Allied Powers was imperatively demanded. As at the time of James Watt there were great trials and tribulations, accompanied by a host of disappointments, so in the electrical application. The world at large will never know of the sore trials, failures and disappointments that attended these conditions.

Again, the world over, did our scientists and ingenious mechanics apply themselves to meet this new and exacting requirement of the steam engine for electric purposes. We now reach a point that may be worthy of attention—at all events, may lead to an idea. How often does the popular mind conceive the idea that the age of steam power is on the decline, and confidently predict that the time is not far distant when electric power will be the sole agency employed? Try to bear in mind, if you please, that since the advent of electric lights and motors the refinements of the steam engine in every respect to meet the requirements have more than surpassed those of the half century preceding.

It may be said, without exaggeration, that during this period the finest intellects have been taxed to their utmost in research of principles to meet the exacting demands of the electrical requirements. Observe, if you please, the magnificent workmanship, far surpassing anything of the kind produced before; indeed, so far has this refinement been extended that special tools were created to produce the perfection desired. Does not this all point to the closer and inseparable union of the two powers, instead of that separation born of the heated imagination?

In the matter of steam or fuel economy, a general survey of the field in this direction reveals results of a marvelous character. Looking back to the period antedating the advent of the electric power, the majority of cases were well content with a result of four or five pounds of coal per horse-power per hour. With the advance in the adoption of the compound system, one and a half and two pounds are attained in practice.

An inspection of one of our first-class plants, fully equipped and properly maintained, cannot fail to impress the appreciative mind with the grand results of the efforts of American students, scientists and mechanics. As you look upon these muscles of brass and sinews of steel as they reciprocate to and fro, and listen to the soft whirr of the dynamo, does it not at times suggest to you the vast army of unknown ones that have burned the midnight lamp over the countless problems that have been solved to bring about such an harmonious whole? And more impressive is the fact that still the never ceasing cycle of time continues with the same mastering passion to do more, to do better, ever reaching out for hitherto unseen forces and powers.

As has already been stated, the results in regulation and economy in engine practice to-day would seem to fill the round of desires or expectations at least. There yet remains much to be done in the direction of design with a view to durability, embracing within itself those qualities which, in a machine of continuous operation, would reduce the wear and tear to a minimum or scarcely appreciable amount. The tendency to a multiplicity of parts or movements in valve gear is to be deplored. This evil undoubtedly has been born with the effort of straining after exceedingly fine points, regardless of the mediums introduced for the accomplishment of the object in view. This complication never fails eventually to make itself known by its prolific fruits, in exasperating breakdowns and interruptions, entailing with the same a train of expenses that frequently assume alarming proportions and culminate occasionally in an entire abandonment of the plant.

In the matter of economy in the adoption of early points of cut-off and rates of expansion, it has been conceded that the positions of pure theorists, governed by the laws of thermodynamics, when brought into the actual school of practice and measured by the searching light of commercial conditions, were at variance. A halt upon this important point was the result, and now these theories are rapidly being modified and brought into close relations with accurate and first-class practice by this over-reaching, as it were.

With the light of the past exhibiting to us a vast number of improvements which have been applied to these powers, many of which, if suggested a quarter of a century ago, would have been considered by the highest sources, to say the least, chimerical. It should not be inferred, by what has been touched upon as to engines, that the fountain head or source of supply has been forgotten, the boiler and its appendages.

The numerous types and systems of steam generators brought to our notice constantly give ample testimony to the continued interest manifested in this important direction. Strength to resist pressure, durability, facility of access to clean and repair, are imperative. For economic results an abundance of steam capacity is requisite to produce the quantity of steam and, what is of equal importance, quality of same. The latter is receiving close attention, indeed, so much as to receive favorable commendations from our compeers abroad,

Never in the history of scientific progress has the world witnessed such a vast army of active minds as have been engaged and are now working in this sphere. Since the advent of these powers the rapid trend of thought has moved on with an impetus that is amazing to us when we glance at but a brief period of the past, resulting in lifting all up to a higher plane. And as this goes on, so will this field for the two powers expand, until the uttermost recesses of our land will be greeted with the movement of the steam engine, the brilliancy of light, and the gliding of the motor.

Under the present auspices, can we not confidently look for greater, more perfect and startling results, with a closer and more perfect union, so that we can say of these allied powers that, "For all ages yet to come, they will hold sovereign sway and masterdom."

FIFTEENTH CONVENTION.

(*Continued from page 16.*)

about 15 miles of duct in use for electric lights; they are using 2,500 volts and $9\frac{6}{10}$ amperes. They report six grounds from January 1, 1890, to November 13, 1891, and all, except one, from too thin insulation.

In one case the cable was damaged before drawing into the duct. They used the creosoted wood conduit; the cost of this kind of conduit is about $4,500 per mile, including manholes. As they have only been in use about two years, it is impossible to judge of their durability.

In Washington the terra cotta conduit is used. This is a trough, $3\frac{1}{2}$x8 inches, each made of glazed terra cotta, laid with a proper cover about two feet below the surface; these are connected by bracket shaped pieces, which hold the joints in position and all laid in a heavy bed of cement; each duct is calculated to hold three 2 inch cables, but the size can be varied. The electric lighting company tried conduits of wood, asphalt and iron, but they all failed; they then used the terra cotta and have found it very satisfactory and reasonable in price, but the cable to be used must be first-class.

In New York city the electric companies could have made a success of the underground conduit work, were it not for the exorbitant prices charged as rental for use of conduits.

In England, many plans have been adopted, with varying success. Through the courtesy of the London Chamber of Commerce and prominent English electricians, we have obtained some information regarding the practical working of various systems. Ferranti uses, for his high tension 10,000 volt current, his concentric cable, composed of a thick copper tube, upon which is wound a number of layers of paper saturated with an insulated wax, over this is slipped a thin outer tube of copper for the return current and drawn down close; then he covers the outer tube with insulation and puts a lead tube covering over that and places same in the ground; wherever there is traffic he adds an iron pipe. Notwithstanding all these precautions, he has had innumerable troubles from grounds, induction, etc.

In Liverpool, the mains are laid in cast iron troughs, then filled in around them with bitumen and covered over with Portland cement; these have answered perfectly for the low tension, but they have not used high tension currents long enough to test their efficiency of durability.

In Bath, Eng., they use a conduit consisting of an iron trough, with iron cover, in which cables with one-half inch insulation are laid on wooden bridges about two feet apart, and after cables are placed in position the whole is filled solid with bitumen and then the iron cover fastened down. On cables laid in this way, they have carried for two years an arc current of 2,500 volts and an alternating of 2,000 volts successfully, only one ground having occurred.

After a careful and extensive examination of nearly all underground work in this country, the fact has been developed that, with very few exceptions, the system and plans heretofore adopted have proved a failure; in some cases caused by improper materials, insufficient insulation, and in many cases carelessness in laying the conduit or drawing in the cable, and in a large majority of cases, from using cable with too thin an insulation. High tension currents can be carried in conduits successfully, if the conduits are properly built and cables thoroughly insulated and carefully drawn in; but it is absolutely necessary that all work and materials should be first-class, no half way business or effort to scrimp and save expense by thinly insulated cables or poor construction.

Investigation plainly shows that a large number of the troubles on underground cables have been caused by workmen in the manholes, as the employés of all companies have access to same; employés of one company have been extremely careless while working over the cables of a competing company and trouble has followed. This shows conclusively that each company should own and control exclusively the conduit in which their wires are placed. The plan of renting conduits is not productive of good results, unless the Legislatures of the various States pass a law regulating the charges made for rental, and this should be the aim of the National Association to see that laws, properly controlling the price charged for rental and use of conduits, are passed in all the States where same are used.

Some substance must be used for the conduit that will withstand the action of the gases, soil, etc., and also resist the affectionate embrace of the Irishman's pick, used in excavating and repairing streets. Iron is not desirable, as under certain conditions and places it will be destroyed in a few months, leaving your cable exposed. Cement alone cannot be relied upon; wooden conduit soon decays, besides absorbing large quantities of moisture. It would seem that glazed terra cotta, or like substance, set in concrete was the most reliable, and with a cable first insulated with not less than one-fourth inch of pure rubber, this covered with a heavy braid well insulated, over this a covering of lead, and then a heavy and substantial braid saturated with a good compound, will give satisfactory results; and can be used with high tension currents successfully and without being troubled with burn-outs or grounds. But this entails a large outlay for conduits and cables.

There is one feature of the business upon which all examinations and reports agree, that is, that the underground plan has been in use for so short a time that it is impossible to give a fair comparison of the cost of maintaining aerial and underground circuits, but it is conceded that the expense of maintaining underground cables is far greater than aerial; also that the durability of conduits and cables, in many cases, are mere conjecture, as they have not been used long enough to test their ability to stand the action of acids, gases and various other requirements, which can only be determined after a sufficient time has elapsed.

The expense of conduits and underground cables is so heavy that they can only be adopted in a few of the larger cities thickly settled, and then the electric lighting companies adopting them must be paid a higher price for service, or eventually their company will be bankrupted by the expense and loss entailed. Therefore, the taxpayers in any city who demand that wires shall be placed underground want to realize the fact that this move means increased cost for lights and larger taxes to pay for same. From data obtained, it is evident that nearly all the cities could be served with aerial lines for high tension current in a more acceptable manner and at less expense than with underground conduits, and they could be so arranged as to be perfectly secure and not in any way endanger the public or mar the general appearance of the streets.

On motion of Mr. M. J. Perry, the report was received, placed on file, and ordered to be distributed to the members of the Association.

Mr. Nichols: I would like to ask one question concerning the report. I noticed that in one portion of the paper it is stated that a creosoted wood conduit costs $4,500 per mile. Is that the price per duct, or, if that was the whole conduit, how many ducts in the conduit?

Mr. Francisco: That is for two ducts in the conduit.

Mr. Hering: I believe no mention was made of the system in use in London and Paris, in which bare wires are run in conduits on glass insulators, a system which seems to work satisfactorily, and seems to solve the problem of insulated coating. The wires are perfectly bare, and supported in glass insulators under the sidewalk. They are easily accessible, as they are covered with flagstones a few inches below the surface of the ground.

Mr. Francisco: In the course of correspondence, I was told that in Paris nearly all the lines are in the sewers on glass conductors. Such a method is impracticable in this country, and I paid no attention to it.

Mr. Hering: I believe that is an error. I was there, and they told me that no electric light wires were allowed in sewers on account of the telegraph and telephone wires. At the time I was there they were laying the electric light wires under sidewalks in special conduits made for them. It was a concrete conduit of rectangular cross section; the insulators were on iron rods extending across from one side of the conduit to the other.

Mr. Wilmerding: I think Mr. Francisco takes a rather pessimistic view of the underground system of distribution. We think that we have succeeded, in Chicago, in transmitting currents underground without any trouble. The reason that there are so many failures in places where they are just beginning to do that work is because they do not do it properly. They try to do it at too small an investment. In order to economize in the first cost of construction, people will put in a wire that is too lightly insulated. There are systems of conduit in the market which are recommended as being insulated, but I do not take any stock in them. The iron pipe for conduits is just as good as a non conductor, except for the fact that it will rust out and become useless in four or five years. The main point to be considered in the conduit is to get a certain strength and elasticity, so as to prevent the conduit from cracking with the action of frost and other causes, and yet be easily repaired. I believe that wood is one of the best substances for conduits we have. In Chicago we have had very satisfactory results with it. We began the work about four years ago, and I had occasion to open the street at one place a short time ago, where this first wood conduit was laid, and I found it in perfect condition, although the weather had been dry for a long while; aside from that, the wood was thoroughly moist; it maintained its moisture all the time. We know that any wood that is kept constantly moist is practically everlasting.

In regard to the liability of the cable, I think I have the right cable, and with sufficient insulation it will carry a reasonable potential for a considerable length of time. I have 40 miles at present of a certain cable, with an insulation in thickness of $\frac{5}{32}$ of an inch, which is carrying a potential of 500 volts on a constant potential motor service of 1,000 volts and an alternating service of from 2,500 to 3,000 volts in arc lighting service, and which has been in service for over two years, and I have not had a single case of grounding, burn-out, or anything of the kind, on 40 miles of conduit.

Mr. Francisco: I would like to ask Mr. Hering if the underground wire is for low potential?

Mr. Hering: Yes sir, it is.

Mr. Francisco: The continuous current was referred to us and we paid no attention to low tension current.

Mr. Hering: I would like to say that the system seem as equally applicable to high as to low tension. It is an aerial line running in the conduit underground. I would add, also, that at the Frankfort Exhibition last Summer, there was an underground cable, in which an alternating current of 20,000 volts was carried for a distance of about a mile.

Mr. Francisco: In regard to Mr. Wilmerding's remarks about wood, I would say, that the entire thing depends on the locality. I can show you a case of wood conduit that has lasted less than nine months, and I can show you other cases where they have been running for 20 years. It depends on the locality and the soil. In some soils you can lay a conduit and have it work all right; in other soils you can lay a conduit and in a short time you will have nothing but a wood pulp that you can crack in your fingers. I would like to ask if they have not had trouble in Chicago with the conduit?

Mr. Wilmerding: I think that is the fact in regard to the city plant. I was told by one of the employés who had charge of the underground circuit, that they had trouble in one of their underground circuits for about six months, and had not been able to locate it. *Of course, that is a municipal plant.* (Laughter.)

Mr. Stanley: When a high potential continuous current is placed in an underground cable there is a great strain on the insulating material, and this strain is all in one direction. As the result of that continued pressure in one direction the constitution of the insulator changes, and after six months, in some cases, I believe in London, in even less time than that, the entire structure of the insulator changes, so that while the cable had a high specific resistance to start off with, that rapidly fell off in the same cable. In the case of alternating currents in these conductors this deterioration does not take place; but in this case the current reverses rapidly, and the work done by the current passing in one direction is quickly undone by the next wave passing in the opposition direction; and thus the effects are neutralized. The effects of the alternating current are more like those of water flowing through a pipe. If we had a long pipe filled with water and suddenly turned it on end, the water would rush to the far end and strike a hard blow, and there would be a water hammer effect. The longer the cable is underground, and the longer the distance, the greater is this condenser effect; and it was so great in the case of the Ferranti main, that it raised the pressure at London a great many volts higher than at Deptford, where the other end of the cable was. I think it can be generally stated that those insulations made from oil compounds are unfit for a continuous current strain, while they are exceedingly good for alternating currents. In some cases in underground work we found that the cables did not have the capacity they were figured for; the capacity being always reduced. The resistance of the cables for alternating current was considerably higher than it ought to be; in some cases ten per cent. higher, and we were worried a great deal about it. We found that the external resistance in this cable was due mainly to the work that was done in the iron pipe which enclosed the cable, the resistance function being outside of the wire and not inside, and also that the current in the wire was not evenly distributed, a result which had been predicted long ago by Sir William Thomson. These difficulties were overcome by adopting a certain small standard size of conductors and putting in more cables.

Mr. M. J. Perry: This proposition to place wires underground, if carried out and consummated, would necessitate the Buffalo Company's earning a dividend on at least double their present capital. We will say you have based your prices on a capital stock—that you have an investment which requires that you should earn $100 per lamp; if the change is made, you will then be obliged to earn $200 or $300 per lamp; but you cannot raise your prices; oh, no. The tendency in prices, in all business transactions, is steadily downward, and you have got to be busily at work to determine and introduce economies that shall take care of that gradual pressure downward; and yet you propose to pay double; and it will be impossible to get higher prices, even though an increased investment should be made.

These are the points that must be very seriously considered. This very instance of the Buffalo Electric Lighting Company that is being considered, when you attempt to force them at once to lay their wires underground. It may be that if public pressure is put on strong enough, that you can make them do it; it may be that you can send them to bankruptcy; and it may be that those who come in on the second deal may reap a rich reward. I do not believe, however, that that is the province of any city government, and I do not believe that it is the intention of any intelligent public to do this, if they have been fairly and squarely confronted with the question.

Mr. Wilmerding: I do not want to be understood as recommending underground conduits for investors. Mr. Perry rather misunderstood me about that. When you discuss this matter as a financial question it assumes a very different aspect, of course. As to the question of the practicability of having currents underground, I must say it is practicable; we know it is. When it comes to the case of investment, it is impossible, with a given rate for service, based on overhead construction, to furnish underground circuits at the same rate. When Mr. Perry assumes that it may cost $200 or $300 per lamp for underground construction he is too low; we cannot do it for less than $400 or $500 for a complete plant. Of course, we had a different experience in Chicago from what the Buffalo company would be subjected to; we never had an overhead construction; never had to throw our overhead construction away. We started in to put wires underground when we began business; but we had no overhead system. After a good many experiments we managed to make a success of the matter, and our stockholders are not entirely neglected.

Mr. Perry: I do not wish to be understood that any figures I made were more than general; they were not actual estimates. I believe, however, that for a capitalization based on $100 for every arc lamp, with poles and wires, it would cost two or three times as much with the underground system, and Mr. Wilmerding simply confirms my position by showing that it will cost more.

Mr. T. C. Martin: I think, Mr. President, that your remarks in regard to Mr. George Worthington struck a responsive chord in every heart in this room. I, therefore, beg to move you that a committee be appointed by the Chair, to consist of three members, to draft resolutions of regret, and that they report at the meeting this afternoon. I do not think that I express other than the sentiments of my colleagues on the electrical boards in regard to our friend, now gone, when I ask that you will appoint on that committee those of us who labored with him.

The President appointed Mr. T. C. Martin, Mr. W. J. Johnston and Mr. Charles W. Price.

Afternoon Session.

Mr. Stillwell read the report of the Committee on the Relation of Size and Efficiency in Transformers. (See page 21.)

Mr. Wm. Stanley, Jr.: The paper is so clear that it hardly requires much discussion; but there is one point which it seems to me might well be noticed, and that Mr. Stillwell has assumed that a non-heating transformer is what we desire. Now, as a matter of fact, the most efficient transformer that could be made, I believe, would be the hottest transformer. I know that Mr. Stillwell understands the subject thoroughly, and qualifies that statement by saying that it should not be so hot as to endanger its life. The problem of building a transformer, is to build a coil of wire and get as much iron in it as you can; that is, to surround a given amount of iron with as many turns of wire as you can; or, to surround a given size or coil of wire with as much iron as you can. I think the table that Mr. Stillwell has given, as to the efficiency of the various sizes, very good. We have had occasion lately, to design transformers of very high voltage, as high as 15,000 volts, and we are now designing some to deliver 40,000 watts of 50 horsepower each. We find no difficulty in keeping the temperature of these transformers within reasonable limits; they will get hotter than a small transformer; it is better that they should; but I do not believe any well insulated transformer is in danger of its breaking down; it depends on the kind of insulation; if you put in mica or if you put in paper, or any stratifying insulation, and subject it to the high potential, it will most certainly break down with that potential by either a dynamic current or static charge or stroke of lightning; but if you fit it with a homogenous insulator, such as oil or some solid insulating compound, you can use any potential you want, provided the discharges do not take place that occur in stratified in-

sulation. I think the heat has very little to do with the breaking down of a properly insulated transformer.

Prof. Thomson: Mr. President and Gentlemen of the Convention: I think I agree with Mr. Stanley in the statement he made in opening his remarks, that the paper is so plain that there is really not much room for discussing it. It states facts, and facts which I have reason to believe are not far from the facts of truth. I do not exactly agree with Mr. Stanley in the statement that a transformer is better when it is hot. I would rather modify that statement in this way, that a transformer would run best if the iron would run hot and the copper as cool as possible; that is, the hysteresis losses of the iron would be diminished by the heat, and the resistance losses in the copper would be lessened by keeping it cool. If we could insulate the core of the transformer so as to prevent the escape of heat, and let it get hot, and keep the copper cool as possible by ventilating it thoroughly, we should then have the ideal transformer. I hardly agree with the statement that Mr. Stanley made that the insulation would not be injured by being hot. It is our experience that you cannot have a machine, a dynamo or any other electric apparatus run too cool, as regards the preservation of its insulation, provided it does not run so cool as to condense moisture from the atmosphere. The absolute resistance, the dielectric resistance, is highest when the substance is cool; that is, the tendency to puncture insulation is much less if you can keep your insulation cool. If you allow the insulation to heat up, its power of resisting puncture certainly decreases. The matter may be briefly stated in this way, if you take a good conductor like copper and run the temperature down, its resistance almost disappears at very low temperatures; hundreds of degrees below zero copper is almost a perfect conductor. If you heat it up it becomes more and more resisting. Let us take glass—a good insulator—or any insulating material, and run its temperature up, it loses its insulating power, and if we run it up until it gets to red heat it approaches a conductor; so that all substances are conductors when they are hot enough; all substances.

Mr. Robert MacKie was called upon and said: My experience has been solely and only with the converters in actual operation, and not with them in the factory or manufactories. I think it would be presumption on my part to follow these gentlemen with any discussion whatever.

Mr. Stanley: I did not mean to imply that it would not injure the insulation of a transformer if you had it hot enough. What I did mean to say is, that so far as the efficiency of the apparatus went, it would rather, on the whole, be improved by heating it. I think Prof. Thomson agreed with me. Of course, we can heat a transformer up so high that it will get on fire; but there ought not to be anything to burn. I question if the transformer of the future will have cotton or any other inflammable material in it. We are making transformers in which, if the coil is cut in two, the copper wires will be found imbedded in a solid dielectric, and the section would resemble the section of a well constructed cable; there is nothing to burn there. A temperature change of 30 or 40 degrees would hardly affect the dielectric strength, while it would materially affect the efficiency of the apparatus.

Mr. Stillwell: Prof. Thomson has fully covered the points of Mr. Stanley's first remark, to which I applied the same criticism as the Professor. With regard to the possibility of making a transformer, using for insulation only such substances as are not affected by heat, while that may be a theoretical possibility, I do not think that any transformer is now offered in the market which will be found to embody that kind of insulation. If you use only mica or something of the kind which is not affected by heat materially, then, in general, I should agree with Mr. Stanley it is well for efficiency to let the transformer run at high temperature. As it is, however, nearly every transformer, so far as I have examined them, does use insulating tape, or an insulating substance resembling tape, in one form or another. It may not be necessary, perhaps, to be guided to any extent by foreign practice in these matters; but in so far as the foreign practice is found to be in line with correct theory, I think it is of some use to us; and it is very noticeable that in the specifications of foreign engineers that they limit both machines and in transformers to a comparatively low temperature. Anything that is done in the direction of reducing the temperature, either in generators or in transformers, by the manufacturing companies is a direct gain to the purchaser; because I do not think it will be disputed that, taking the apparatus as it is built, such a policy tends to prolong the life of the apparatus.

Mr. Perry: In behalf of the central station men who come here simply as learners from these gentlemen, I wish to move a vote of thanks to the gentleman who presented this paper, and to those who took part in discussion. I will venture to say that we central station men have learned more in this paper, concise and clear as it is, and in this quiet discussion, brief as it has been, than we would have been able to learn about transformers from the itinerant representatives of the transformer builders in a half dozen years. (Laughter.) I refer, of course, to facts. I want just to make one more point on a matter that has been under discussion and consideration by the National Electric Light Association, and will be, I suppose, for some time to come, as each side of the question has its friends and advocates. I say that if by having two conventions a year you can get two papers a year like this, you cannot afford to hold only one convention.

The motion extending a vote of thanks was carried.

The Committee on Safe Wiring, by M. D. Law, chairman, then reported the following proposed amendments to the rules on that subject:

INSIDE WIRING.

Art. 7. Inside conductors must not be laid in plaster, cement or similar finish, without an exterior metallic protection.

SPECIAL WIRING.

In rooms where inflammable gases exist, the incandescent lamp and socket must be enclosed in a vapor tight globe. This is not understood to include rooms where illuminating gases are used in the ordinary manner.

Art. 2. The word "water-proof" change to "moisture-proof," so that the article will read: provided with a durable moisture-proof covering.

INTERIOR CONDUITS.

Art. 2. Interior conduits must not be of such material or construction that will be injured by plaster or cement or other surrounding material, or that the insulation of the conductor will be ultimately injured or destroyed by the elements of its position.

After a brief discussion, the amendments were adopted as read.

Mr. Allen R. Foote read a report of fires and injuries caused by electric currents during the year 1890, being data obtained from 425 cities in the United States: Number of members on fire force, regular and volunteer, 56,498; total number of fires for which the force was called out, 39,847; total number of fires caused by electric currents, 518; total number of injuries received while on duty, 1,719; total number of injuries received while on duty at fires caused by electric currents, 35; total number of injuries caused by electric currents while on duty, 31; total number of fatal injuries received while on duty, 60; total number of fatal injuries caused by electric currents while on duty, 1.

In the brief remarks following the reading of the data above, it was elicited that in the case of the single fatal injury caused by electric currents while on duty, that the man fell from a pole 35 feet high, and as there was no autopsy, it could not be learned what was the exact cause of death.

Mr. Lane, of Cleveland, O., addressed the meeting on the subject of lubricating oils. He said that most people were under the impression that it was necessary to use lubricating oils of high viscosity and low gravity in order to get good lubrication on heavy or high speed machinery. He said that after extended experiments it had been found that a light oil, light in gravity and low in viscosity, was the oil that would give the best satisfaction in the lubrication of both high speed and heavy machinery. In the case of machinery running at very high speed, an increase of oil will increase the temperature; and unless you use oil enough to absorb the heat, so that the oil will run away taking the heat with it, you cannot reduce the heat by a large amount of oil; that is, if you use more than is really necessary for lubrication, but fall below the point necessary to carry the heat off with the oil. The oil recommended by Mr. Lane was an oil of about 32 gravity and 140 viscosity.

The paper on the "Allied Powers" was then read. (See paper by Mr. Ashworth.)

On motion of Mr. Seely a vote of thanks was passed to the author.

Invitations from the Brush Electric Light Company at Niagara Falls to visit the Falls, and from the Buffalo Railway Company, to inspect its power station and plant, were read.

The meeting then adjourned and the delegates spent the afternoon in inspecting the power-house and plant of the Buffalo Railway Company.

Tuesday Evening Session.

The President called the Convention to order at 8.20 P. M., and said: "The nature of the meeting of our Association to-night is to listen to papers upon long transmission of power by high tension currents. I need not say to the people of Buffalo that this is an interesting topic, and I trust that before you go away you will learn a good deal as to the possibilities of utilizing the Niagara Falls. You will also listen to a demonstration, or illustration, of the Lauffen-Frankfort power transmission. I take pleasure, ladies and gentlemen, in introducing Mr. Carl Hering, of Philadelphia."

"TRANSMISSION OF POWER WITH SPECIAL REFERENCE TO THE FRANKFORT PLANT."

In order to appreciate more readily the fact that the advantages of electrical transmission over other methods are well founded and are not mere vague claims made by its advocates, let us review briefly the other methods, all of which have been in use much longer than the electrical one, and have had a chance to show their limitations. Most of these are without a rival in their own narrow fields, but when it comes to transmission over long distances, the electrical method stands almost alone. Mr. Hering then reviewed the method of transmission of power by means of shafts and belts, wire rope, by water direct, by steam, by gas as a fuel, and by compressed air. Regarding transmission by compressed air, he said that it was, perhaps, the chief rival of electrical transmission, quoting, "it is at present used chiefly in mines, where it is still a very successful rival of electricity, but from present appearances it is likely that it will gradually be replaced by the latter method. In Paris there is a large central station for the distribution of compressed air, and it seems to be in successful operation. It does not appear, however, that the advantages over electrical transmission are so great that it will not soon be replaced by electricity. Its introduction is not making the rapid strides that the introduction of electricity is now making. Its efficiency as compared with electricity will be showed very well at the Niagara Falls power plant, where I understand a compressed air system is to be introduced in competition with electricity. One of the disadvantages for power purposes is in the fact that when the compressed air expands in the engines it generates cold to such an extent as to seriously affect the working and lubrication of the engine. It appears that fires must sometimes be built to heat the air before it can be used at all in the engines. The advantages over a boiler and a steam engine are, therefore, greatly reduced. From a paper by Professor Unwin it appears that the transmission of power by compressed air is practically to a distance of at least 20 miles. It seems that 10,000 horse-power can be transmitted to a distance of 20 miles in a 30 inch main at 132.3 pounds per square inch with a loss of pressure of only 12 per cent. The efficiency of such a plant is said to be 40 to 50 per cent. if the air is used cold, and 59 to 73 per cent. if the air is reheated." Mr. Hering then gives a tabulation of the relative efficiencies in per cent. for different distances of several of these systems:

Distance in Miles.	Efficiency in Per cent. Hydraulic.	Pneumatic.	Wire Rope.
½	50	55	91
1	49	54	85
3	41	51	61
5	37	50	43
10	26	43	21
13	18	39	11

"The most usual and extended method of transmitting power," he continued, "if so it may be called, is that of transporting the coal itself from the mines in the manufacturing cities." He showed that the efficiency in engineering terms in Philadelphia, which is not far from the coal regions, was only 50 per cent. The great waste of coal in our present railway systems was commented upon. Coming to electrical transmission he contended that if continuous currents were used it was not practicable to exceed five or six thousand volts at the very most with dynamos with commutators, and that, therefore, there was little chance of its being used for more than comparatively short distances. "The field, is therefore, left tolerably clear for alternating currents. We owe it to two features. One, that the alternating current dynamos require no commutator; the other, that such currents may readily be converted from low tension to high current and the reverse, with but a small loss of a very few per cent. in each transmission. An alternating current dynamo for generating low potential currents is the simplest kind of a dynamo, and a transformer requiring no moving machinery is a very simple thing to take care of if indeed it requires any attention at all. Simplicity alone, therefore, is very much in favor of alternating currents. The only serious objection to the use of simple alternating currents for the transmission of power is that they are not so suitable for running motors as direct currents are. There is a class of motors called synchronous motors which are, as a rule, simple alternating current dynamos used as motors, like in the case of direct currents. These must be run at a speed which must synchronize with that of the dynamo. They run very well after they are started, but many of them come to a dead stop if overloaded sufficiently to retard their speed below that of synchronism even if only to a slight amount. Their chief fault, however, is that they cannot be started readily; furthermore, all the load must be taken up before they can be started at all. This makes them unfit for many purposes, as elevators, street cars, shops, etc." Mr. Hering expressed the belief that this objection would not continue to exist very long, as several methods had already been devised for overcoming it and others being worked out, and stated that at Frankfort motors were there run not only with the same ease with which continuous motors are run but with additional advantages, which make them far preferable even to the best continuous current motors. He then gave interesting particulars regarding the size of the plants installed in this country, showing efficiencies of transmission for a direct system as high as 73 per cent., and the alternating 75 per cent. for comparatively short distances, also a table of figures prepared by the Oerlikon Company, of Germany, taken from the plants actually installed by them, mostly in and about Switzerland, in which the cost per effective horse-power delivered reaches as high as $121.10 for a distance of five miles. He then gave brief mention of the chief features concerning the power transmission plant used in the Lauffen-Frankfort experiment, commenting in particular upon the three-phase alternating current system which was there used, and which he stated Ferraris and Tesla seemed to have invented originally and independently of each other. One of the most remarkable features of this experiment, even to an electrician, was the transmission of several hundred horse-power by means of a few wires about the size of a hair. 16,000 volts were used and the greatest amount of power transmitted was about 180 horse-power. As regards the cost of a plant as per horse-power, measured at the terminals of the lamp, the Oerlikon Company gives a figure of $382, of which $236 is for the lights alone. "These figures appear high," said the speaker, "but it must not be forgotten that in this particular plant there were conditions which would not be likely to occur in practice, namely, relatively small power on the one end, and extremely great distance on the other, both of which factors naturally increase the cost per horse-power. It may be of interest to add here that Mr. Dobrowolsky, of the Berlin Company, states that he will be willing to bid on the contract to transmit a 1,000 or 5,000 horse-power from Niagara to Chicago, a distance of about 500 miles. He proposes to use 40,000 to 50,000 volts, and claims that an efficiency of 60 to 75 per cent. could be obtained without difficulty.

Mr. Hering then added: I received, this morning, a letter from the Zurich people—the Oerlikon Company—who, you may know, have put in a bid for the transmission of power from Niagara Falls to Buffalo. They propose that the current generated at the Falls is to be such that both motors and lamps—arc lamps as well as incandescent lamps—shall be used; that is, the current shall be fit for motors, arc and incandescent lamps. They say as the rotary current is at present, and will be for a long time to come, the only practical form of current to run large motors of a fair efficiency, we have proposed their use. They propose to use 50 periods in place of 40, which were used at Lauffen, because they say that 40 is too low to run arc lamps. Fifty is said to be the lowest at which arc lamps will run satisfactorily. The generating station would be composed of units of 5,000 horse-power each. The dynamos must therefore be of 5,000 horse-power. According to the wishes of the turbine designers the number of revolutions has been fixed at 250 per minute. The diameter of the armatures has been fixed at 3⅓ meters, that is about 10 feet. The armature is to be drum wound. I suppose that means the drum winding on the surface of the cylinder, that is not across the ends as we usually wind drum armatures here, but wound as they very often do in European multipolar machines. The currents are to be 2,000 amperes in each of the three circuits, and the voltage 600 to 700. It has been found advantageous to revolve the armature instead of the magnetic field, in order to have a minimum weight on the vertical shafts. The generator will have 24 poles. They will be separately excited. The efficiency will be in the neighborhood of 96 per cent., that is the efficiency of the dynamo including exciting power. There will be two transformers, as it was not found practical to build a single transformer of 5,000 horse-power. The transformers will be artificially ventilated, and only the high pressure coils will be placed in oil. These transformers will raise the potential to 25,000 volts. "This" they say, "is no longer to be looked upon as a venture." The cost of the line will be about 100,000 francs, that is, $20,000, an almost trifling part of the whole.

Mr. Law: Is that per mile, or for the total distance? For the total distance, I imagine.

Mr. Hering: Twenty thousand dollars—that is, for the total distance. It is a simple pair of copper wires—that is, three pair of

copper wires on poles—the cheapest kind of a line.

"As to the line, we propose not to carry any more than one or two units of 5,000 horse-power on one line of poles for a number of reasons." A 5,000 or 10,000 horse-power can be conducted on wooden poles at a very moderate initial cost of plant. "The lines would terminate in one or more step-down transformer stations that would supply current of 1,800 to 2,000 volts for municipal and street lighting in the shape of alternating currents to be transformed down to the suitable lamp voltage, as is the case in the present transformer systems." "The cost of the electrical part of the proposed plant, including the generators, exciters, and transformers at both ends of the line, would be about $180,000 for each unit of 5,000 horse power, with an efficiency of 84 per cent. at the low pressure terminals of the secondary transformers." This reduces to $36 per horse-power, which is lower than the lowest one in the table that I read to you. "The cost of the line is about $4 per horse-power, which is about 10 per cent. of the whole."

(The speaker then illustrated the apparatus referred to in his paper by the use of photographic slides.)

The President: I take pleasure in introducing to you one whose name is known to you all, Prof. Elihu Thomson, of Boston. (Applause.)

Prof. Elihu Thomson: I am sure the thanks of the Association are due to Mr. Hering for the able paper which he has presented, and which covers a great many points. I have not very much to add, indeed, to the subject matter of the paper. He has had the opportunity of examining for himself the working of this grand experiment abroad which has resulted apparently successfully. In the beginning of the paper he referred to various modes of transmission, and justly selected electrical transmission as the coming means of the transmission of power. We have in the case of the cable railway an example of wire rope transmission, and we all know—all those who have taken any pains to look into the matter at all—that there are very great losses in such a transmission unless it is confined within narrow limits. It is a common saying that very much the larger portion of the power in a cable system is used in pulling the cable around and that the addition of the loaded cars to the cable makes only a moderate addition to the power required to move the cable. This is certainly true if we have a system in which there a number of curves, the cable has to turn corners, and I have no doubt the figures given by Mr. Hering relate to cases of cable transmission in which the transmission is practically straight, where there is an open country, as it were, and the rope transmission can be carried across. If a good many curves or bends are to be made in the system, of course, the efficiency runs down very rapidly. But in reality with electrical transmission we may bend our wire as much as we please; we may turn as many corners as we please, and it simply adds a little to the length of the line, which can be made up by adding to the copper used a slight amount.

He has spoken, also, of the compressed air system, which is used in Paris. I believe the system was originally introduced there for the operation of clocks and finally extended to the working of compressed air engines. In that system it was found that the engines did not work efficiently unless the air was put through a heater, the reason being that when the air is compressed at the station it loses during compression a large amount of energy, which is converted into heat, and it has to be thrown away by cooling arrangements, cooling the compressing pumps. It then passes along the distributing points at low temperature—at the ordinary temperature. The moment it reaches the engine and begins to be expanded in the engine it demands, to resume its normal condition, that the heat which it lost during compression be put back into it, and, of course, if it does not get that heat it simply chills—cools—and comes away from the engine very cold. The bad effect of this cooling of the air is, that it not only shrinks the air in volume and, therefore, relieves the pressure on the piston, on which you rely for the development of power, but it hurts the mechanical working of the engine; so that the practice in Paris is to put up a little stove and pass the water through a coil of pipe in this stove before it reaches the engine, and in that way they get a very fair efficiency out of the compressed air system. But it is by the addition of this extraneous heat, and the consumption of fuel. It is true that the heat which is added to the compressed air as it enters the engine is very efficiently used. It is almost all converted into mechanical power. In fact, if we had a supply of compressed fluid at our disposal at very high pressure, and then were to heat that and allow it to expand down to ordinary temperatures, we would have a very efficient way of using heat and converting it into mechanical power; but the pressure would have to be very high to make that a system that was useful. Mr. Hering has also mentioned in his paper a form of transmission which is not ordinarily classed as transmission of power, that is, the carriage of coal from the coal regions down to a city where it is to be used. That is in reality a transmission of power; and if we had a gravity road—if our coal mines were up in the hills or in the mountains, and we ran the coal down by gravity, starting the cars at one end, allowing them to go down with practically no use of power, carrying back the empty cars only, we should find that we had transmission of a very efficient kind, indeed; that we would get, outside of the wear and tear of the road, practically no expense in conveying fuel. That the efficiency of conveyance now is no greater than 50 per cent. is probably due to some manipulation; it seems to me it ought to be higher. It ought to be possible, for example, to get down to Philadelphia from the anthracite coal regions a ton of coal without its costing as much again as the coal costs to mine it. However, I do not know that I have investigated that subject sufficiently to pass a proper opinion; whether the coal will ever be burnt in the mining regions and the power developed there transmitted electrically, of course, is a question to be considered. It depends upon the cost of carriage relatively to the cost of the carriage of electricity. If it should turn out that the plan of conducting the power electrically should give a lessened cost of carriage the electrical plant must, it seems, take the place of the road in carrying coal—not, perhaps, for the development of heat—not for the development of heat—we are not likely to burn the coal at the mines and carry the electricity 50 to 100 miles, and then use the electricity for heat—but for power. Heat is a different thing. We need to get a very large fraction of the energy of the fuel in the case of heat, and for power we are content to get 10 per cent. or 12 per cent. in the steam engine, and use that. It has been aptly stated in a paper read to you that the commutator difficulty is the difficulty which stands in the way of the application of direct or continuous currents to power transmission. It is an actual fact that a commutator which is to stand indefinitely 3,000 volts is very expensive in construction. It requires very high insulation, very careful construction, and very numerous segments. It has been found impracticable to raise the electrical pressure existing between two adjoining segments on the commutator beyond a certain amount. The current is apt to leap the gap between the segments and form short circuits. Therefore, for high voltages, we need to divide the commutator up into very fine divisions. But that involves that the winding be also divided up. It makes it very difficult to wind the armature and connect it to such a commutator and the difficulties are undoubtedly great. I think the limitation would naturally be found somewhere between 2,000 and 3,000 volts for actual practical usage; that is, so far as the commutator is concerned, and if we attempt to transfer power that one potential reducing it, we do not get rid of the commutator at any step of the process where we use direct or continuous currents. Now we are driven, then, as Mr. Hering says, to alternating currents; and he has shown in a paper that a very excellent example of power transmission by the alternating current is to use what is known as the three phase system with "double conversion," as it is called. That is, to generate at one end of the line high potentials, and pass the low potential currents through what thus becomes the coarse primary of the transformer, and rises into the fine secondary high potential currents which are fed to the line. Those high potential currents go through the fine wire of another transformer, which is, like the first, simply reversed. The low potential currents are then taken from that transformer and utilized for motive power. The fact that transformers of large size can be built with very high efficiency, a loss of only a very few per cent. is, of course, in favor of the system. The fact, also, that there is no need of manipulation of the dangerous high potential currents is a great thing in favor of such a system. The only thing against it is the addition of apparatus, and the necessity of taking great care of the insulation in a transformer. This difficulty of insulation, however, in the transformers seems to be overcome by immersing the transformer in a bath of insulating oil, when we find that it takes a very high potential to puncture even a moderately thin layer of oil. We find, for example, that one-half inch of oil will stand many thousands of volts—voltage beyond what we are likely to be called upon to use in practice—far beyond it. In other words, we can construct our apparatus with a considerable margin of safety by allowing the oil insulation to be thick enough.

I am greatly in favor of the three-phase system. It seems to me that it is a symmetrical system—one allowing you to do almost anything you please with it. You generate at one of the line, by the use of power obtained from, it may be steam, from coal burnt at the mines, or from coal slack, which is a waste product oftentimes of the mines. You generate your power very cheaply. You transmit those currents to the line, or if you have a water power you do not generate the steam, but you use the water power to drive this dynamo. You are ready then to make the transmission. The only question in my mind is to whether you should take your lines over ground or under ground. It is certain that if you went under ground you would not require to paint on every pole a skull and cross-bones. Currents of voltage up to 51,000 or 20,000 volts are, of course, certain death if a person comes in contact with them. We are approaching the condition of lightning—continuous lightning. That is not simply a stroke, but a continued stroke—a great number of strokes following each other in rapid succession; and it does seem to me that, all things considered, perhaps it would be a little more costly to begin with, but for moderate distances should not be prohibited cost to put the lines in pipes filled with oil, and use, in other words, the same insultation which is used on the transformers throughout the line. Beginning with a transformer in oil, you carry a high potential conductor in a pipe filled with oil to the further end. In other words, put the whole high tension part of it in oil—insulate the whole thing in oil—and bury the pipe. In that case, of course, unless somebody digs it up and interferes with it or gets into the iron pipe which encloses the three conductors, you are practically free from any leakages due to wet insulators or interference due to lightning. A thunder-storm may come up and the three lines on the poles are innocent enough until a stroke of lightning falls somewhere near, when you have damages to your transformers or to your machines. This can be said, however, in favor of a high potential system that the liability of damage by lightning is less the higher your potential. In other words, the nearer you approach lightning in the operation of your plant, the less liability there will be that lightning will interfere with the operation of such a plant. It is constructed to stand a moderate phase of lightning, and it would take a considerable addition to break it down. At the same time, the oil insulation regulates itself the moment it is punctured. Such a line might, in a measure, be struck by lightning and might be deranged for a moment but, the oil passing in between, that would be the end of the difficulty. It is very different where the apparatus is not constructed to stand more than 3,000 or 4,000 volts instead of 20,000 or 30,000. There if lightning comes on to the line and you are not provided with all safeguards—and, in fact, if you are provided with them all, if a direct stroke of lightning falls on the line, the question is whether damage is not going to result. There are some other points about the three-phase system that I would like to bring out and emphasize. It seems to me that we can do a great many things with it. For example, we can get alternating currents at the receiving end for the running of lights direct from the mains; that is, by convertion down at any voltage. We can, therefore, run any kind of apparatus which operates with single-phase alternating currents or with multiphase alternating currents. We have at our disposal, motors which can be run, and efficiently run, by the means of three-phase currents directly fed to them without excitation field. That is, motors which do not synchronize, motors which do not run at proper speed quite under load, but nearly the proper speed—very nearly—they run fairly well; and they are adapted to distribution here and there. But we can also run a machine from the same system of mains which we use, which is a reserve alternating dynamo, which is perfectly synchronized. That is if the generating plant runs at 120 or 150 terms, the motor plant at the other end of the line may run at a definite speed depending upon the generator speed, at the same speed or some definite relation, and stay at that speed during operation, not vary a particle, be perfectly synchronous. Now, in case, for example, we wish to lump our power in the receiving station and run at absolutely steady speed we might use the reserve dynamo, reserve three-phase dynamo, as a motor, and get synchronizing speed. We can distribute by the other form, non-synchronized form of motor without any field excitation at all, and we may run lines. But suppose we desire to get continuous currents from three-phase currents, suppose, in other words, we have an existing plant which is based upon the use of continuous currents. There may be street cars that are already equipped; there may be mains laid in the streets which are adapted to use just certain pressures, and there may be motors running from those mains which are only adapted to use continuous currents. Then we have resort to another kind of a machine, a machine which takes continuous three-phase currents and delivers from the other side continuous currents, which has no commutator on this end, but simply three wires, and on the other end a low potential commutator, a commutator which gives you no difficulty in running 110 volts, 220 volts, 500 volts. We may then convert directly from the three-phase currents into a continuous current, and supply the existing mains which are to be found. And we may do that efficiently. We can have from the same system, a motor generator it would be called, which is supplying 220, 110, 500 volts, separate machines, or we could even put them in the same machine; and, furthermore, we can make such a machine so that it will compound itself. In case, for example, the machine is running with very little load, its potential will be, say, 220 volts. In case the load is thrown on, naturally there will be a fall of potential in the whole transmission from one end to the other; there will be a fall of transmission all the way through, and a fall of potential even in the mains which are found in the streets. That fall of potential can be made up by the construction of that machine. In other words, we can compound this motor generator by simply taking the accessory field and exciting that, making that field by the secondary currents. That will raise the potential, and the system then becomes a completely compounded one.

Now, in closing my remarks, I will simply state that you can imagine what such a system would do from New York city. We have separate plants, stations, in the city here and there using expensive ground, expensive buildings. Supposing we go up the Hudson somewhere and establish a power plant, get our coal very cheaply delivered, get water for condensing the steam in the engines, get rid of ashes by making land somewhere, and we simply lay pipes down to the city, a distance of whatever number of miles is convenient, making the pressure what we find is proper for economy in transmission. We deliver current, three-phase it may be, to the different stations. That is, simply use motor generators feeding into the existing mains. Should we wish to run out new mains transformed down to low pressures we can do it very easily. In other words, we can satisfy almost every need, even down to the plating current; we can give everybody what is required from such a system.

Now, the question as to what pressure is the limit—what is the electrical pressure that would limit us in such transmissions as we are talking of—well, there really seems to be no particular limit. It would seem to me practicable, if it were necessary, to raise the pressure to 100,000 volts. It simply means that you have got to have your oil laid thick enough not to be perforated—your insulator oil thick enough not to be perforated by 100,000 volts. And in some recent experiments I have made I find that oil is excellent well adapted to stand such pressures. It is even better than solid glass. Where glass breaks down with perfect ease, I find the oil stands up, and if it does break down it reinsulates itself. If there is a puncture through the oil and a spark flies, it is not necessarily the case that is the destruction of the plant, but the oil slips in and covers up the defect. (Applause.)

The President: I take pleasure in presenting Mr. H. Ward Leonard, of New York.

(Mr. Leonard's address appears on page 33.)

The President: We will be glad to hear from Mr. Stillwell if he is here.

Mr. L. B. Stillwell: I will not detain you long by comments on the very interesting article that we have heard, and the subsequent discussion; but in listening to the very complete discussion of the Lauffen-Frankfort transmission plant, I made a few notes of a desultory nature, which may be of some interest as throwing some additional light on the possibilities of power transmission and as intimating what manufacturers in this country are prepared to do. One might get the impression from what has been said to-night, and also from the fact that by far the most daring attempt in the direction of power transmission has been carried out abroad, that American firms and engineers are not prepared for this as yet; but it should be born in mind in considering what has been done abroad, that it was under government supervision, and that the installation was practically paid for by three of the German States.

There are several firms, at least, in this country who would undertake to do practically the same work if we could get the backing of three of the German, or three of the American States. The synchronous, two-wire system is itself adapted to many of the purposes by which we desire to transmit power. In combination with the two current apparatus for the distribution where the distance is considerable, and where it may be sufficiently economical to pay for the alternating current generator, a line from an alternating current motor, have a director generator, this combination to-day is available. Of course, we have to figure out the probable cost of such a plant installed, and in general we have to figure against the operating expenses of a similar plant located at the point where power is to be used and doing the same work. I think, however, that beyond the combination of synchronous and direct current apparatus, and superior for most purposes without question, however, is the multiphase or two-phase alternating. It is adapted practically to every purpose for which we

may use power, while it is equally adapted to lighting. Mr. Tesla's work in the direction of rotating fields, motors having rotating fields, is pretty well known; but it has been carried forward and perfected in a great many details since Mr. Tesla ceased to give it active attention. There are one or two points that are of interest with reference to the methods used at Frankfort. One of them is as to the comparison of the two-phase with the three-phase system. In the three-phase system the differences of phase between the three circuits is technically 120 degrees. In the two-phase system it is possible to produce a rotating field which will start motors with a strong torque intended to have a phase of 90 degrees. It has been found that where more than one motor is to be run, or where lights and motors are to be run, there is considerable difficulty in maintaining proper phase relations between the different currents of the three-phase system. The fact that in each of the subdivided circuits the relation of line resistance in inductive resistance will vary, tends sometimes to drive the current practically out of one of the wires. There is some reason to think, then, that a two-phase, 90 degree system would be preferable for combination work. The synchronous plant that has been referred to, that has been installed at Telluride, is one of considerable interest. The generator is one of a construction adapted to high potential, and delivers current to the line at a potential at about 3,300 volts. This potential was selected not with reference to the travel or distance, two and three-quarter miles, which is the distance at which the only motor now operating is located, but with reference to a distance of eight miles, it being the intention to locate other motors at different mines along the range up to that distance. The work for which it is employed, namely the running of a stamp mill, is of a character where we do not care for varying torque and for varying speed. The motor runs practically all the time. It runs 24 hours a day, and at least six days in the week. I believe that, all delays figured in, since the starting of that plant the actual time it has been out of operation is only 16 minutes per day, all things counted in; and of the total delays, about 80 per cent. were due to difficulties in the regulating of the turbines. That suggests another point with reference to the operation, not only of two-wire synchronous systems, but of the three-wire. As Prof. Thomson suggested, it is certainly possible to operate even the three-phase motors as synchronous motors when the units are large. If there are no small units I can see no objection to doing that. You have the torque to move them up to the speed, but when they are at the speed, why let us have the advantages of the synchronous running, because there are advantages to that. For example, one of the difficulties in combining this kind of plant with the hydraulic plant is in regulation. If there is a thoroughly turbine regulator on the market I have not heard of it. A great many circumstances will influence and alter the speed of the turbine, and rather suddenly; and if we run in synchronism our entire load—the motor and all that it may drive, counter-shafting, stamps in a stamp mill, or any other work that it may be doing—will act as a fly-wheel for the turbine, and the effect is advantageous. It is exactly as if we had a line shaft running from our generator to our motor holding them rigidly together.

With reference to using step-up and step-down transformers, it seems to me that they should only be used when the distance we wish to cover exceeds a certain amount. I do not believe that for a distance of less than 10 miles in general it would pay us to use them. They not only add to the complication of apparatus, but they necessarily add a considerable amount to the necessary investment, and if you omit them, the problem simply becomes to properly insulate our machine and to provide for making the necessary changes of circuits without unnecessary or undue danger to those handling them. All these not only can be, but have been accomplished. Switchboards are devised in which it is impossible for the attendant to touch either pole of the high tension circuit.

There is another point which is somewhat interesting with reference to the three-phase as compared with the synchronous. One advantage of the synchronous system for certain plants, particularly for power plants in the West, is in the simplicity of the wiring. I have known at least one plant where fluid insulators were recommended and were furnished by a manufacturing company, and were refused by those installing the plant for the reason that in the West the soil, or the rock, is so hard that they cannot cut it to erect their pole lines as they want to, and the consequence is that the poles are stuck up at all angles, and the fluid insulators ordinarily made are liable to spill the fluid, and they would not use them. They use instead an ordinary glass insulator with bare wire, and that is what is used at Telluride with over 3,000 volts successfully—has been used all through this Winter, which has been a very severe one—which, by the way, is a more severe and practical test than that which the Lauffen-Frankfort plan submitted was, although that worked at so much higher pressure. (Applause.)

The President: We will be glad to hear from Mr. C. S. Bradley.

Mr. Bradley: It happens to be my good fortune to have worked on this line—I hope it is a good fortune (laughter). The gentleman who has just spoken, has spoken of the 90 degree two-phase apparatus, and speaks of it as better than the three-phase. I don't see any reason why the three-phase should not maintain its relationship just as thoroughly as the two-phase, which are 90 degrees apart. Then there are some things about the third phase—there are three wires, and those three wires can be taken off into three separate circuits. That is, it would take six wires to carry them off and separate them into three alternating circuits. That is, those six wires will show you that the subdivision is final. In one of those slides that we saw showing the diagrams of the phases, you noticed that the third phase was finer—the lines were nearer together, than the two-phase; and this shows that the third phase is a more even distribution of magnetic field than the second phase. I have worked on both lines and I have always thought that the third phase—it has always proved more satisfactory to me than the quarter phase, as we call it, or two-phase. Of course, there will be a great deal of controversy in regard to these things, and there is a great deal to be still proven. We are in our infancy in that line as yet, although we are trying to get the machinery ready as fast as possible to meet this work in this field. I thank you for your attention.

The President: If Dr. Bell is here we will be glad to hear from him now.

Dr. Bell: I am a little inclined to look at this matter from the point of view of the fellow who wants a power plant put in and wants it immediately. What can he get that will meet the necessities of the situation? Now, in power transmission we have, I may say, three very radically different situations. In the first place there is transmission of large horse-powers over a few miles, such, for example, as the plant at the Calumet and Hecla mines, and at other points within the mining regions all over the country—places where the distances of transmission are not very great, still far greater than any with which we have in the past been thoroughly familiar. There are many cases, I believe, every engineer will recognize where the very simplest solution is to use existing current apparatus in as much as the necessary voltage will not be over 1,000 or 1,500 volts, and if there appears to be excessive drop on the line, let it drop and use 500 volt motors at the other end. There are plenty of cases where all the conditions of transmission, even of 1,000 or 2,000 horse-power, relatively ranged, can be met in a straightforward way, and met on short notice, by half a dozen companies. That is one phase of the situation. Then we come to another phase of cases where the distances are considerable, and yet not great—even small compared with that magnificent experiment at Lauffen. There we have the choice between several methods. We may use the very high pressure, direct current, as has been successfully done in Italy, over a considerable distance; or we may use the synchronous alternator or polyphase alternating currents of any number of phases from two up to as many as you please. Now, the synchronous alternator has some advantages which I do not think should be forgotten. When, for example, as sometimes happens, as in the Telluride plant, it becomes necessary to pick up a certain unit of power, say two or three or four horse-power even, and transport it bodily, to be used in a single unit at another point seven days in the week, the question of a self-starting motor becomes of little importance. In the Telluride plant, I am informed by the superintendent, the motor is run from Sunday night practically to Sunday noon, night and day, and the only work of the starting motor, the small Tesla motor, is for a few minutes once a week. In such cases as that the advantages gained from any self-starting system whatever are comparatively slight, especially if the wiring is going to be complicated. And then, finally, we reach extraordinary situations where powers must be transported a long distance. And yet, there is something to be said in favor of apparatus other than that which has been often suggested for the purpose.

I fail to see the particular usefulness of raising your pressure to 35,000 volts for the sake of securing an outlay in the amount of only $4 or $5 per horse-power when, in order to do that you have to use transformers costing somewhere about $40 per horse-power. It seems to me that a little less pressure put in the line and a little more copper would enable the transmission to be carried out at a lower pressure, decidedly; that 20,000 volts, with equal efficiency, and with the advantage of having the investment in copper, which does not deteriorate seriously, rather than transformers, which may, and sometimes do, deteriorate. Of course, there will be a point where it will be necessary to use step-up and step-down transformers; but I think the point ought to be emphasized that until distances become quite great it is a pretty even question between the cost of line and the cost of transformers, the advantages of durability being on the side of the line, the efficiency being the same, and the initial cost the same.

Then, as regards the question which has been raised several times to-night, of two versus three-phase motors, it seems to be a question not yet quite decided. Whether either one of those systems will answer all the requirements where a large number of motors are to be run in parallel, that is one bit of experience which the Lauffen experiment did not furnish us. It taught that we could transmit power an enormous distance with a fair efficiency, and with at least scientific success.

It did not tell us whether those conditions would be suitable in case we had to run instead of one motor and a bank of lamps, 40 or 100 motors; that is one point that needs experiment before we are fairly to say outright whether we should prefer two or more phases, or whether some form of alternating motor which may very soon be devised and which will run on the ordinary alternating system, requiring only two wires, may not enter the conditions even better than the polyphase motor. It is simply a question of experiment and on that we need further information. In the present situation it does seem to me that a great deal of the discussion between the defects of the various systems forgets, for a moment, that much of what is to be done in the next year or two must be done under the conditions where we are working now. Much of it must be done with existing apparatus, and the man who will make the most thorough success of the transmission of power in that field, is he who will attack each seperate problem, doing the best he can with the apparatus which he can get, and not tying himself up absolutely to either continuous or direct currents, to two-phase, three-phase, or any phase motors, but seize the opportunities for transmission of power as they come, and make the best of the situation with the best apparatus that that particular moment commands.

Mr. Carl Hering: I would like to correct a figure of Dr. Bell's. According to this estimate from the Oerlikon Company, the line cost four dollars per horse-power, and the *total* plant cost $36. Not $40 for the transformers alone. The $36 includes transformers and dynamos and everything.

Dr. Bell: I would simply say that those figures for transformers were obtained practically for minimum price from a well known transformer manufacturer in America. We are not dealing with general prices. Of course it may be that eventually we will get down to a set price. I am simply giving you what it can be bought at this day, this particular day in February. I would like to say, though, that there is a big difference in running a small transformer and a large one, that is, where you deal with 2,500 horse-power. Now, the cost per horse-power there would be much less than in such transformers as are in use at the present time.

Mr. H. Ward Leonard: I have been very much impressed by the figures ($36 per horse-power), and was when it was first given. I agree with Dr. Bell that it seems very different from American prices, leaving entirely outside the four dollars per horse-power for line, and even abandoning the converters. It is not possible to-day to buy in the market in America motors and generators at a price which would be $18 per horse-power of such character as would be required for this work; and when the converters are added, it seems to me the price can only be explained by cheap labor.

Mr. Hering: I do not guarantee anything can be done with those prices. I am simply giving you what was said to me.

Mr. Martin: One statement made by Mr. Hering in regard to periodicity—I think the Oerlikon people were ready to make a contract for an apparatus at the rate of 50 per second. Now, my impression, from what I read and learned with regard to the Lauffen-Frankfort transmission, was that they never succeeded in getting at any time above 25. Is that so?

Mr. Hering: I understood that they ran 40 normally.

Mr. Martin: Mr. Bradley, how much did you understand it to be?

Mr. Bradley: I saw the plant running three or four days at 23. It seemed to be very difficult to get above it.

Mr. Martin: That was my impression. It makes a great difference, Mr. Chairman. I noticed in Mr. Hering's paper that the losses in all the line followed Ohm's law. Is that actually the case?

Mr. Hering: Practically.

Mr. Martin: I am under the impression that in transmission, when it happened to be damp, as it sometimes is around Buffalo, there was very little potential at the other end.

Mr. Hering: On the contrary, at Lauffen they said that tests made during wet weather showed so little difference that they could not detect it with their commercial instruments.

Mr. Martin: Then we get different information, Mr. Chairman.

Mr. Hering: I did not make the measurements myself.

Mr. Stanley: It may be interesting to the members of the Association to know that there is a line of 15,000 volts in operation in this country. We have constructed a small line at Pittsfield, using 20 horse-power, fed by the station currents—the line starting at the outskirts of the town and making quite a little circuit. We find that there is practically no difficulty whatever at that potential. Fifteen thousand volts, however, is a very different matter than one, or two, or three, or five, or ten, or 12,000 volts. The striking distance at 15,000 volts is apparently two or three times what it is at 10,000 volts. For instance, if the wire hangs down from the line within an inch or two from the ground there is a most delightful aurora borealis between the ground and the wire; and if a dry board be imposed in the circuit, it does not seem to affect the resistance of circuit a particle. It goes right through it. We are making these tests at Pittsfield to become familiar with this question from a commercial standpoint, and have undertaken to transmit 400 horse-power, for lighting purposes, a distance of 28 miles in one place in this country.

The delightful lecture given by Mr. Hering, does not, however, give us some of the points which, as engineers, and as practical men, we need in examining and testing the merits of the various devices. For instance, Mr. Swinburne wrote me the other day, from information that he had received, the Dobrowolsky motors—two-horse power motors—requiring 4,200 watts to run at no load and 14,000 watts, or ten times its rated capacity, to run it at its full load. I do not mean that 1,400 watts are expended in the circuit, but I do mean that of the current apparently applied, viz.: 14,000 watts, but 1,500 are actually used full. If this is an example of the engineering practice on the other side, I am very certain that my friend, Mr. Stillwell, can tell us that it is far below that obtained by Tesla. If I understand them correctly, the Tesla motor uses about .6 of its full load current to run it empty, .7 of which is usefully applied. That is to say, about .7x.6x, the total energy, is required to run the motor empty. The synchronous motor has certain very beautiful applications, but it has a very serious defect in my judgment; that is, that when the motor is overloaded beyond a certain point, not only the motor stops, but she goes to pieces—burns up—or she is very liable to burn up. I do not see how any commercial system of distribution of power can be made when we have to start our apparatus by a weight, as suggested by one gentleman; or by another motor, as suggested by another gentleman; or by three special circuits which will not work in multiple, except they work alone, the plan suggested by Dobrowisky.

In the case of the transmission of power between Niagara Falls and Buffalo, I had occasion to visit Niagara Falls with the eminent engineer, Mr. Maxim, and while I am quite certain that 15,000 volts could be loaded on the circuit between that place and this, I am equally certain that no large amount of power by the present apparatus can be transmitted successfully; I mean with commercial success. If we are going to bring Niagara Falls to this city—or a small portion of Niagara Falls—we have got to adopt some scheme radically different from anything that has been presented at the present; as the scheme that Prof. Thomson suggested, and lay our wires at 100,000 volt pressure in an oil pipe; I cannot see that there is any half-way solution of the problem.

Mr. Martin: It seems to me that we cannot carry on experiments to amount to anything unless we have a great deal of outside assistance, either from the German Emperor or the three States. I would be very glad to move, and have it formerly considered, that we ask the Standard Oil Company to loan us one of their pipe lines (laughter and applause), and place it at Prof. Elihu Thomson's disposal, and then, perhaps, we will know a little about this thing and what it does cost.

Mr. L. B. Stillwell: I beg to differ with Mr. Stanley. His statements were really something new and revolutionary in order to attack this problem of transmitting power from Niagara to Buffalo. I think that we are to-day prepared to make an estimate, and to back it up with guarantees of operation that will cover a plant that may be criticised from every standpoint. There are several alternative plans, in fact, which could be adopted with good results. In transmitting power from Niagara to Buffalo you may deal with a small amount of power. We deal with the delivery of from 5,000 to 10,000 horse-power, and in doing that, even if we go as high as 15,000 volts without figuring it, I am quite confident we will take four wires instead of two to transmit 10 horse-power 30 miles. Now, doing that, we could use the two-phase arrangement with 90 degrees difference, which will maintain their proper relation no matter whether we use large or small motors, and we would use four wires on our poles, two wires carrying

one current and two wires carrying the other current, 90 degrees apart. You won't increase your copper; in fact, the copper will be exactly the same amount as will be required by two synchronous motors of 500 horse-power. The advantage of using four wires instead of two is that it affords a good ultimate potential which is, of course, what we work to. Now, I have personally quite recently made an estimate and proposal which has been forwarded by the Westinghouse Company to the proper parties—the parties asking for it—and involving a distance of a few miles greater than that from the Falls to Buffalo and calling for the transmission of a number of hundreds of horse-power. In this instance, being an initial plant, we have been willing to guarantee operation for a period after installation, so I do not think that any one contemplating the erection of a power plant need wait until something new happens. As is well known, the efficiencies of all these motors are now very high. All these things are almost reduced to simple arithmetic; they are easily to be calculated, and do not involve factors as numerous or unknown as is popularly supposed.

The President: Are there any further remarks on the subject?

Mr. Martin: I would like to move, Mr. Chairman, that a vote of thanks be tendered to Mr. Carl Hering for the very interesting, important and valuable paper we have had this evening. Carried.

Adjourned.

SECOND DAY—FEBRUARY 24.

Forenoon Session.

The President called the meeting to order at 10.30 A. M., and the first business was the reading of Mr. Schieren's paper (see page 32).

Mr. Stanley: I would like to ask if there is any choice in the placing of the leather, whether it is better to place the heads all in one direction and the tails in the other, or whether there is any difference in putting the grain of the leather irrespective of the direction of the belt and the direction in which it is running.

Mr. Schieren: I can answer that question readily. In order to make a straight line belt, we have to use heads with heads if the belt is made of anything else than centers; in using centers this is not necessary. The center is perfectly straight, and it is only by the greatest stupidity on the part of the workman that you can make it crooked. He can make it crooked by stretching one side more than the other. If we had to make all our belts from centers, it could not be done. In making belts of other than centers there is a right and left, and the workman must be careful not to change the relation. Crooked belts often come from the fact that the workman will put a left on a left, and then again a right on a left. The joints should be made shoulder on shoulder and butt on butt.

The paper of Mr. William Stanley, Jr., on "Alternate Current Motors," was then read.

[Mr. Stanley's valuable paper, which indicated his discovery of a thoroughly practical alternate current motor will appear in full with the discussion next week.—ED. REVIEW.]

The President: We were to have had yesterday a report from the Committee on the World's Fair, but it was not ready. We have with us to-day an eminent gentleman from Chicago who will present a report from the World's Columbian Fair Committee. I have the honor, gentlemen, to present Prof. Elisha Gray, of Chicago.

Prof. Gray: I am very much obliged to you, gentlemen, for giving me this opportunity to address you; it is not alone my work, it is yours also. I think you had, at your last meeting, some discussion on this subject. We have a plan to form an auxiliary organization in connection with the exposition, and it is called the World's Congress Auxiliary of the World's Columbian Exposition. There are several departments and each department will hold several congresses. Ours comes under the head of science and philosophy. We want your aid and support in making a success of the electrical congresses which are to be held under this plan. We would like you to appoint a committee to advise with the general committee in charge of the congresses. We invite all electrical societies to co-operate in the same way.

The President: Mr. Price, of the World's Fair Committee, is here, and he has a letter from the Chairman, Mr. Sunny, which he will read. I understand it is somewhat in the nature of a report.

REPORT OF THE WORLD'S FAIR COMMITTEE, READ BY CHARLES W. PRICE, OF THE COMMITTEE.

National Electric Light Association:

Gentlemen—It is the source of the deepest regret to me that it will be impossible for me to attend the National Electric Light Association meeting at Buffalo. I fully expected to be able to be present, but find it impossible to be away from Chicago at this time.

Everything in connection with the World's Fair undertaking is moving in a most gratifying and satisfactory way. The buildings and grounds are getting into a finished condition with an expedition that promises an absolute completion of the work long before the date for the opening of the Fair.

From Professor Barrett I ascertain that almost double the amount of space available for electrical exhibits has been applied for by American and foreign electrical manufacturers, and that there is apt to be just a little disappointment by parties who will not be able to get the amount of space that they will require. I think, however, that the arrangement for the care of applicants is on such an elastic basis that every one will get about what he wants.

This statement may be combated by some, because of the newspaper articles that have recently appeared to the effect that important European manufacturers have not been able to get the facilities that they desire to make a magnificent exhibit at the World's Fair. I am familiar with the application of this firm, and I know that any disappointment they have met with has not been through any fault of the World's Fair management. They required a great many things which could not be granted, for the reason that American manufacturers would require the same advantages, and they could not be allowed without practically abandoning the plan adopted after much consideration and hard work.

As has been announced by the papers, the specifications are out for the furnishing of 6,000 arc lights and 92,000 incandescent lights, and 3,000 horse-power in generators for the service of the Fair, and by the middle of March the contracts will be closed, so that the work of installation can go right ahead.

The organization of the World's Fair Auxiliary, under whose auspices will be held the Convention of the electricians from all over the world, is going forward rapidly and satisfactorily, under the direction of Prof. Gray, Chairman. The aim of the Committee is to make the undertaking the gathering of electricians on a comprehensive basis, and with the assistance that is being offered the Committee in every direction, I have no doubt but that the plan adopted for the Convention will be the one best calculated for the advancement of the interests of electricity.

The situation could not be any more satisfactory for the prospects of the undertaking than it is.

B. E. SUNNY, Chairman.

On motion of Mr. J. A. Seeley, the report was received and ordered placed on file; it being understood that the committee was to continue.

Mr. George M. Phelps then presented the following resolutions, in behalf of the committee appointed yesterday:

Resolved, The members of the National Electric Light Association, assembled at its Fifteenth Convention, desire to record their sense of the loss sustained by the Association in the death of Mr. George Worthington. He was the moving and leading spirit in calling together the company of gentlemen who organized this body seven years ago; and so long as health and strength remained to him he was foremost and unwearied in its service. From the first he appreciated the importance of the organization and its possibilities of usefulness. Busy as he was in his chosen field of journalism, he found time and opportunity to lend a hand on every occasion of service. Highly as we regard the memory of his ability and usefulness as a working member of the electrical committee, we even more highly cherish the remembrance of his warm.th of heart and his unselfish devotion to his friends. No one came within reach of his hand-grasp without becoming his friend. If he had an enemy no one ever found it out.

Resolved, That the Secretary be requested to send a copy of this minute to the family of Mr. Worthington.

On motion of Mr. J. A. Seeley, the resolutions were unanimously adopted and ordered to be engrossed and a copy presented to the family of Mr. Worthington.

The meeting then adjourned until 8 o'clock P. M., the afternoon being devoted to a trip to Niagara Falls.

Wednesday Evening Session.

The President called the Convention to order at 8.30 P. M.

The President: The first paper will be on the use and construction of switchboards, by Mr. M. C. Sullivan, of New York. In the absence of Mr. Sullivan, his brother, Mr. Sullivan, of Chicago, will read his paper and represent him.

"THE CONSTRUCTION, SAFETY AND OPERATION OF SWITCHBOARDS."

The switchboard may be likened to a pilothouse, or what is technically called the "conning tower" of a modern war ship. In the early days of naval construction, the pilothouse was of no more importance than the pilothouse of an ordinary steamer nowadays; but keeping pace with other improvements, it was soon discovered that this point of the modern iron-clad was the nerve center of the vessel. From here the immense machinery, the rudder, the firing of the guns, signaling, in short, every force which the ship may possess, was controlled from one point. Appreciating this importance, the designer has surrounded the conning tower with every possible safeguard and exhausted every ingenuity known to the shipbuilders' art.

The switchboard is, or should be, the pilothouse of your station. Here should be located means for determining accurately the working of the entire system down to the minutest details. Disable your switchboard and like the wrecking of the pilothouse of a man-of-war you are helpless. The great advantage to be gained from centralization has been lost. It must, therefore, be apparent that every means should be exhausted to perfect and protect this apparatus.

The large composite stations, embracing arc and incandescent lighting, of both high and low tension, and power generators for street railways, condensation is one of the vital features. A most effective way to build a switchboard for stations of this character, is to have it arranged in the form of a square, so that one side could be devoted to each division of the service.

Stations occupying a large open floor with high ceiling presents the opportunity for building the ideal switchboard. This could be raised above the floor a sufficient distance so as not to occupy any valuable floor space. For this matter, it might be suspended from the ceiling. The wires from the dynamos could run directly to the left, thence through the switchboard, and from the latter to the cupola, arranged as nearly over the switchboard as possible. This arrangement would give us a central starting point for our lines, enabling us at once to trace each and every wire of the system.

The prime object to be secured in switchboards for high tension service is safety, not only to the attendants, but to the station. The necessity for this received a terrible emphasis when the famous Grousvenir Gallery, Ferranti station, at London, went up in smoke, because of a poorly constructed switchboard feeding and incipient arc. This can be accomplished by having every part of the board over which current is transmitted insulated in such a manner that contact from the front is impossible.

This prime necessity of switchboards in railway power stations is facility for rapid manipulation, whereby any part of it can be reached in the shortest space of time. Here, also, the indicating instruments must be within plain sight so that the movement of the current, with its rapid vibrations, can be readily noted.

In low tension incandescent station plants, with their multiplicity of circuits, and the necessity for manipulating things quickly so that whenever interruption may occur will be reduced to a minimum, there is no limit to the refinement to be obtained. It can be reduced to the simple question of putting switches in circuit, or we can design the board in such a manner that it will be universal throughout whereby any dynamo or dynamos can be placed on one line, or several lines on one dynamo. It is not necessary or advantageous to have the board arranged in the form of a perpendicular wall. It is just as well to design it so that the switches can be arranged in the form of shelves up the front of the board; or, in the case of extremely large stations, the board itself could be made to occupy the whole of the floor space in a room and the instruments fixed on tables, leaving an alley between each table of sufficient room to get around readily. These tables need not be of any great length, for should they happen to be, it would take too much time to reach certain points. They should be cut in sections so as to make the distance to be covered as short and direct as possible.

All switches and apparatus for this service should be manufactured with a lug or extension of the contact, so that the connection could be made from the back of the board. The resistance boxes and all of the regulating apparatus, which requires considerable space, should be placed behind the board and provided with a rod extending through the face of the board. The board should be as symmetrical as possible, so that in rapid manipulation the grasping of the wrong switch cannot occur.

Rapid manipulation being essential in arc light stations, although not in the same degree as the three other types of station, this feature is one that must be considered.

A very convenient form of board for this service is to arrange two slabs of marble, or slate, or other form of insulating material, leaving a distance of, say, six inches. One slab, say the inner one, may have connections from all the dynamos, each dynamo circuit having its own bar. The outer slabs contains holes through which the current from these dynamos circuits may be plugged into any circuit or circuits, making it a sort of checkerboard arrangement, the square being defined by the line wires running horizontally and the dynamo circuits running vertically, or *vice versa*. The plugs by which the circuit is completed should have hexagon insulated handles so that a good hold could be had. All the lightning arresters, ammeters, etc., should be placed directly on the slate, or what may be used for the purpose, and the board should be complete in itself in every way before any wires are attached. Binding posts can be provided for the connections, and the work of disconnecting any circuit from the dynamo-board is but the question of a moment. As cables will be necessary in the different combinations, a trough should be provided along the front in which the slack can rest to prevent them falling to the floor.

We now come to the most important feature of the whole question. What material should be used for our switchboards? As it must be fire-proof the use of wood is entirely prohibited. We must, therefore, look for something entirely different. Various efforts have been made to make wood fire-proof. This has been accomplished to a limited degree. Slate, as many of you know, is the best thing that nature has yet offered us. For strength, lightness and insulation, it is the only material in sight. Unfortunately, however, slate is an alluvial deposite of a laminated character and often contains metallic substances which destroys its insulation. When in the rough stone it is hydroscopic to a considerable extent, and when it becomes saturated with moisture makes surface leakage possible. Great care should be, consequently, exercised in selecting slate for switchboards, and only that which possesses absolutely no metallic properties be used.

The drawbacks met with in slate have determined some manufacturers in using marble for this work. This has only one-fifth the breaking strain of slate, and where it is used in the place of slate this must be taken into account. Marble presents the same hydroscopic elements of slate and there is some metal in it, but owing to its peculiar formation, this metallic substance is not in any great quantities as it is between the laminations in slate.

Iron should be used for the framework of all switchboards, and in the case of high tension circuits a wire should be run from this framework to the ground, which is entirely insulated from the circuit.

The President: The question of switchboards is one that comes home very close to every man in a central station, and there is probably no point that central station practice is so weak in as in good switchboards. It is a very noticeably weak place in the construction of a station which I have something to do with here in Buffallo, and I am not alone in that, as exceptionally few of the stations that I have been in have modern switchboards. I will call upon Mr. Scott to speak to us upon this subject.

Mr. Scott: We have got a wooden switchboard, and according to the paper that has just been read, that is contrary to law. But I am willing to bet that it is fireproof, because it is wired in such a manner as to make it so; and I have found that the great danger from fire with switchboards is either from a dirty connection, a loose screw or from lightning. We have had trouble from all those causes, and in order to obviate the trouble from lightning, we provided each feeder with a double lightning arrester. We have two lightning arresters on each leg of each feeder running to separate grounds, so as to be certain that if one lightning arrester does not act, the other will. Then, in order that it shall not reach the main plug cut-out to the dynamo, we put a double fuse block cut-out on each feeder, and fuse that only to the limit of that feeder, fusing the dynamo cut-out to the limit of the dynamo, so that if any lightning does pass the lightning arresters and comes in, it takes the feeder cut-out instead of the main cut-out, from which it might arc and destroy the armature. I think a plain wall of well shellaced hardwood is better than slate, because edges and corners are susceptible of attack, where a full board is not so liable to it, and I like the full board better on that account.

We have one of the wooden Westinghouse lightning arresters on each feeder, then we have one of the marble lightning arresters on each feeder. We have had some terrific thunder-storms that have come in and stopped the engine, but the arresters have carried them off.

Mr. Robinson, of Minneapolis: The matter of switchboards is something that has given us a great deal of trouble. We started in when we put in our Westinghouse plant with what is known as a Spencer plug switchboard, and, as this gentleman has just stated, we also have some terrific lightning. Our switchboard is of wood. I have seen lightning flashes come in there that would destroy a switch and would not even phase the safety fuse; so that we have come to the conclusion out there that a fuse is not a protection against lightning; neither is a lightning arrester.

The President: I think that Mr. Leslie will appreciate the position that we are now in, and will give us a description of his switchboard in the Manhattan station.

Mr. Leslie: I beg to say that we have suffered very severely from lightning in our station in New York. On one occasion there was a bolt of lightning came into the cupola and agitated all the lightning arresters, but at the same time burnt out our station. That set us to thinking about a safer board. We then laid the matter before a manufacturing company, and they built for us a rubber board—that is to say, a slate board with rubber handles; and there was rubber all around it. And that burned one time when there was no lightning; burned out from arcing in throwing over a heavy load from one machine to another. Then we set about building a switchboard on our own account, and we finally devised one which we think answers the purpose and affords us absolute safety. It is made up of slabs of marbleized slate, and the machine connections are run horizontally on that board and connected up by wires running from the machines overhead, and the connection is made behind the board. The line wires do not come into the switch proper at all. There is an addition to the switchboard, on top; that is

a pecular switch—a final switch. But this switch is arranged so that it makes a connection on each side of the board. If you throw it up, the x, let us say, will make connection on the face of the board, and the — will make connection on the back. Both the line wires are connected with this switch, but they are securely insulated from each other, so that there is no possibility of short-circuit there. The result is that we have a throw of about 18 inches, and no arc on any load that we have thrown there yet will follow it, although our lines are very long and the arcing is very severe. The board made up in that way, is exceedingly simple, and there is no possible chance for a cross or contact between different exciters or different machines. We use the plug system, and the board is arranged in two sections, so that if we are carrying our load on, say, nine or ten machines—we have 20 in the board—why, we set up the other section with the other machines, so that in case anything happens, just the moment that you throw over those switches you will start the whole load on the other machines. There is nostudying out how to do this, that or the other thing, but the board is always prepared for an emergency beforehand, and lies there in readiness for just the unexpected to occur. The whole success of the board is in that throw-over switch that I have mentioned—that final switch. It is quick, and we sometimes make switches there that are very difficult to detect in the effect on the lamp itself, it is so sudden. The board itself, as I said before, is of slate, and there is no wood to speak of about it at all. We do not believe in wood, because we have been burned out on account of wood.

We had bad luck with lightning arresters, so we discarded them, and, although we have passed through two Summers of very heavy lightning storms, we have not suffered any more damage in the matter of armatures than we did previously when we had lightning arresters.

Mr. Fairbanks: We have one of the Thomson-Houston slate switchboards, one of their latest pattern. I do not know that I can describe it so that those not familiar will understand it. It is through the back and front. The lines come into the back part of the board and the machines are connected in the front. Connections are made with a plug which reaches from one board to the other. There are in our board 20 circuits, so arranged that we can couple any line or any machine with any circuit. It avoids all cables, and it is perfectly safe. There is no place about the wood where a person could receive a shock in any way. There is nothing that could in any way reach the wires, and, in our station, our switchboard is situated in the center of the station, instead of at the side. The line wires go out overhead, and before they go to the wire tower they go through the lighning arresters, which are situated right above the board, in plain sight of the dynamo tenders, and where they can be easily reached.

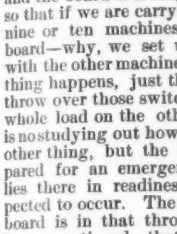
President Huntley then brought up the matter of the Electrical Congress to be held at Chicago during the World's Fair.

Professor Gray explained that none of the societies would meet as organizations, but that all electrical men were invited as individuals to take part in the proceedings under the auspices of the World's Congress Auxiliary. The Electrical Congress would consider all matters connected with the subject of electricity.

He recommended that all clubs, societies and associations appoint committees; then later these committees or an executive committee from them could get together and map out what was to be done.

On motion of Judge Armstrong a committee of three was appointed (Judge Armstrong, F. W. Cushing and Captain W. L. Candee), to take up this matter and report on Thursday morning what action was advisable in the premises. Mr. Erastus Wiman, of Staten Island, was then introduced and read a paper, as follows:

"PROFIT AND LOSS OF ELECTRICITY."



It would seem as if in the evolution of progress on this continent that electricity was the flower and fruit. The stupendous change which, in the condition of the human race, has been possible by development on this side of the sea needed just such a revelation as is possible only in electrical science. A drama of such proportions, on a stage of such magnitude, by a people of such intelligence, illustrating such principles as self-government, such events as a material progress beyond all that the world had ever seen, needed, above all things, a new force, a new hint from the mysteries of the unknown, a new law of nature as forceful as gravity, as helpful as heat, as widely diffused as air. Electricity thus takes its stand just at its right place in the marvelous procession of events in the human progress towards a higher and nobler life which has been rendered possible by the discovery of America.

The speaker then touched upon the high principles and purposes which animated our forefathers as laying the foundation for the material progress to which all the world has contributed.

Electricity, even in its early stages, had played a not unimportant part in contributing to the growth of wealth, to the comfort, safety and happiness of our citizens. The power of the telegraph in this direction was commented upon at length, showing how enterprise was stimulated, all movement quickened and the news spread abroad the land.

The use of the railway telegraph has practically doubled the tracks of every single track railroad on this continent, rendering the movement of trains so precisely, so rapidly and so safely that without this facility of instantaneous communication the railroads would not have achieved half which by its aid has been accomplished. So that, incidentally, electricity is to be credited with no small portion of the enormous results attributable to that vast system of communication, which in the last half century has done so much in making this vast continent blossom as a rose.

He then spoke of the wonders of the telephone and its marvelous growth, and added a tribute to Bell, Edison and the others, who not only invented this device, but by an exercise of the highest business sagacity have elevated it into a condition of usefulness in a few short years well-nigh universal.

The introduction of the electric light with the stupendous results following were then noted.

"Many," said the speaker, "can even now remember, especially in country places, the tallow dip, the short sixes, the oil and spirit lamp, and the uncertain though mellow rays of the finished wax candle. It is quite within the memory of many men here that petroleum with its wonderful power of illumination was discovered, and all the world has since been blessed, not only by its illuminating power, but by the business skill and sagacity which, through the Standard Oil Company, has diffused this article so universally, so safely and so cheaply; illustrating the high benefits of a well managed monopoly, as against the universal condemnation of that economic feature of the hour."

He then reverted to the remarkable progress made in the adaptation of the subtle current to artificial illumination for all purposes.

Indeed, so far has it come to be now a universal street light that a prominent president of one of the largest gas companies in the country declined to avail himself of an automatic street gas lighter at a mere nominal sum, simply because he said it was useless to compete longer against street illumination by electricity.

As an article of merchandise, the light furnished by electricity was just as much in demand to-day as wheat or corn, as beef or bread.

The question of profit remained to be decided in very many localities. He had recently received many letters from central station companies all over the United States on the commercial aspect of electric lighting and from them his conclusions were:

First, that there is an enormous demand, only as yet partially developed and partially met, for electric lighting; second, that the public have been led to believe that it can be created for very little money; third, that in competition with gas, an insufficient price has been asked for a light infinitely more brilliant, infinitely greater in candle power; far more healthy, and, as a rule, far more safe; fourth, that at the start of many electric plants, the most meagre and insufficient foundations were laid for a business requiring the utmost precision and the most perfect material. If a mill for the manufacture of cottons or woolens were to be erected, the greatest possible skill would be required, the best material needed, and the most perfect engineering ability obtained. But in numerous electrical plants this kind of expense was thought unnecessary. The result has been, that numerous establishments have been created that needed almost everything in the shape of good construction that could make it a mechanical success.

It is these conditions, coupled with the rapidity with which inventions have followed, one upon another, the constant reduction in the price of electrical machinery, the rapid growth of electrical appliances, and the radical changes and methods, which in six months would appear to be old in the history of a business which was so new and making such tremendous strides, as make it exceedingly difficult to maintain the expenditure on capital account within the original limit of corporations.

But these changes are not confined to electricity, but extend quite as much into the domains of mechanical sciences generally. Probably no commercial enterprise has so stimulated the inventors of steam apparatus as has electricity. Indeed, it has brought out a new order of things entirely in this respect.

Mr. Wiman recounted the many improvements made in electrical and mechanical apparatus, appliances and material, due to the growing necessities of the rapidly advancing art.

Turning to the erroneous idea that the public held as to the cost of producing the electric light, he said:

The public estimation of the cost of electric lighting has been allowed to prevail to an extent destructive of profit. There has been a hallucination prevalent that there was something miraculous about the production of electricity. The cost of coal, labor and machinery has not entered into the calculation of either the ordinary city official or the private customer. The expectation that something would be produced for nothing, which inheres in the human mind as to the possibility of invention, has attached itself to electricity more than to any other element in the supply of human wants. The consequence is that, in making new contracts, even to-day, there is the strongest disposition to get the prices down, not to what the article can be produced and paid for, but for the least possible amount, irrespective of profit, and equally irrespective of efficiency. There is a true and false economy, and that is the falsest kind of economy that expects a public service at less than its cost and output and profit.

Figures were given to show the result of seven years' business, conducted under very favorable circumstances and under the best of management, which showed a handsome return upon the capital invested, and a totally different picture was given in the case of five electric light companies in a certain city where competition had been excessive.

The true policy, the speaker contended, of the friends of the electrical industry should be directed in just the opposite course to that which you propose pursuing, namely, to show that electrical undertakings upon the basis of the present prices *are not profitable*, and if they expect perfect service they must pay better prices, prices that have prevailed because the companies themselves have not heretofore appreciated and understood the cost of operation, and the great loss due to accidents and rapid depreciation.

These two extremes of success and failure tell the whole story of electric lighting in the past seven years. The companies that have succeeded have done so under favorable circumstances, with a freedom from ruinous competition, exacting good prices, and, above all other requisites, with good management. If there is any department in human activity where brains and tact are required to a degree greater than any other, it is in the administration of an electrical lighting plant. This is evident, not only because there was great lack of experience and knowledge of a business that was in the production of an article that was, in a certain sense, mysterious and unknown, but because there has been an amount of misapprehension as to its cost on the one hand and its value on the other, hardly ever experienced regarding any article of merchandise.

One misfortune with which central stations contended was the fact that the large investment was available for only a small portion of the time, this was gradually abating, however, as the use of electric power for manufacturing and other purposes was increasing, thus putting the wheels in motion during the hours of the day when light was not needed.

He spoke of the proposed transmission of power from Niagara to Buffalo, and of the great impetus which the successful accomplishment of this undertaking would give to power transmission on a large scale.

"If," said he, "in the city of Buffalo and from the Niagara river there can be transmitted power in such enormous proportions as are now contemplated, subdivided and reduced, so that into every factory and almost into every house the force and energy can be controlled and operated, there is latent in every central station the possibilities that may come to every town in the country and to all the electric light plants now lying idle during the day, an imitation in modified form of the power that, of all forces in the world, Niagara is the best example."

The remarkable success which has attended the introduction of electricity to traction, with the marked advantages that have followed, were treated in an interesting and comprehensive manner, and he urged the central station companies to undertake the furnishing of power for roads conveniently located to their plants as a means of increasing their output and consequently their profits.

Mr. Wiman concluded his very instructive paper expressing great hope for the future of electrical enterprises.

"The future is full of promise for these undertakings," he said, "especially in the value of the franchises, the ability to furnish power, in their combination with the gas industries of the country, which must be only a question of time, and in their ability to promote and to assist in the application of electricity to street railway enterprises. The whole subject of electricity, as applied to business, is full of the deepest interest, and no one who feels grateful for having been born in this age, and enjoying all the advantages of the most advanced civilization, can fail to recognize in this wonderful force the advantageous contributions toward the good of mankind, and hold in high estimation the men who, in so short a period, have so rapidly promoted its introduction and high degree of usefulness."

Judge Armstrong: I feel that it would be a very proper thing for us to say to Mr. Wiman, who has devoted a great deal of research, a great deal of time and a great deal of consideration, to this most admirable paper—I think it would be a proper thing for us to say here formally that we thank him for it. It seems to me that he has taken the right view, the view that we ought to take of many of the enterprises in which we are engaged—an obligation owing to the people, a recognition of the benefits produced, and the demand for a return of consideration from those whom we so serve. It is a very admirably written paper, a paper that I have hugely enjoyed; and I would desire to move a vote of thanks to him for it. (Motion was seconded and carried.)

Mr. Wiman: I am very much gratified at this action on your part; and these words of commendation, from so good a judge as Judge Armstrong is, have been very gratifying to me.

Convention adjourned to 10 A. M. Thursday.

THIRD DAY, FEBRUARY 25.
Forenoon Session.

Vice-President M. J. Francisco called the meeting to order at 10.20 A. M.

The first business was the reading of a paper by Allen R. Foote.

"MUNICIPAL FRANCHISES FOR QUASI-PUBLIC CORPORATIONS."

"I believe that an American economic system is as necessary to American industrial independence as was or is, an American political system to American political independence.

"The particular feature of foreign economic systems to which objection may be incidentally made in this paper, is State or municipal ownership of industries. Those who advocate such a policy in this country are wrongly educated foreign socialists and college professors who have been educated abroad.

"A franchise," said the speaker, "is the title deed upon which quasi-public corporations are founded. A perfect franchise should legally contain every provision that is essential in a deed to real estate, every provision that is required to establish the rights of property, every provision that maintains the rights of free labor."

After discussing municipalities and the object of their founding, he entered somewhat at length upon the subject of municipal needs and then stated, as follows, what true economic conditions demanded that these requirements might be properly satisfied:

"First, that a corporation organized to supply a perpetual municipal need shall have the exclusive right to perform the service perpetually.

"Second, that the service shall always be supplied by the best methods known to science, that are made commercially available by the best practices known to the art.

"Third, that all accounts shall be honestly and correctly kept, that economic thrift be insisted upon in every department and that charges be so fixed from to time, by a competent and disinterested tribunal, as to yield a revenue sufficient to pay all fixed charges, expenses of administration, operation and maintenance, and a reasonable per cent. dividend annually upon the investment."

Mr. Foote enlarged upon each of these conditions in a very happy manner, showing a full mastery of the matter in hand, indicating the shortsighted character of present methods of short term franchises and deprecating the performance by municipalities of quasi-public services.

"For," the speaker concluded, "every time an industry is removed by legislative enactment from the list of self-producing industries and placed in the list of non-profit producing industries operated under government ownership, an avenue to industrial independence is closed. Profit-producing industries are avenues to industrial independence and economic freedom for all who are engaged in them. For the wage-workers, more than any others, the self-interest of the individual, the moral interest of society, the group interest of the municipality, State, and nation, demands that *all avenues to industrial independence and economic freedom shall be kept open.*"

Mr. Armstrong: I do not feel like discussing this paper, for the reason that there is so much of it, and there is really so little with which we can theoretically disagree. I do not mean to say, that it is impracticable. It may be possible to get all the citizens of the State to join together with all the stockholders of a corporation, and in looking only to the best interests of the body-politic, you could, possibly, get such a consensus of opinion and agreement as would be willing to give eternal life to a corporation to do things eternally demanded. We have had this question discussed in our meetings before, and we know that there are so many elements entering into the question of municipal electric lighting that it cannot be done as cheaply as by private enterprise. We are anxious to furnish at the cheapest possible price this form of city lighting. We are willing and anxious to receive only a fair profit, and give the service to the people as cheaply as we can. When we can get the people to properly understand this question from a commercial standpoint, we shall have no difficulty in obtaining renewals of our franchises, so that they shall be practically perpetual, and the advantages set forth by Mr. Foote's plan will be gained in that way; but we cannot do it by government work, by law; we must do it by the education of the people.

Mr. C. E. Scott: I agree with Judge Armstrong in all he states. I think it is only by the education of the people that we can do anything. The tendency of Legislatures has been steadily towards removing restrictions when granting charters to electric lighting companies.

The paper by Richard Hammond, "How to Fire a Steam Boiler," was next read.

"HOW TO FIRE A BOILER."

It has been said "That the waste of fuel due to improper firing is often of more consequence than any other loss which is produced in the operation of a steam plant;" but in a great many cases the waste of fuel cannot be entirely charged to improper firing, as there are other causes by which a waste of the evaporating power of the fuel is produced. The principal of these are:

First, the improper construction of the boiler in relating to grate surface, tube area, heating surface and combustion chambers; unless these proportions are properly worked out, it matters little whether the firing be done by mechanical means or by the more intelligent fireman, waste of fuel must necessarily follow.

A great many contrivances have been placed on the market, such as mechanical stokers and other means by which coal and air can be supplied to the furnaces of steam boilers for the purpose of obtaining good combustion without producing a waste of heat by allowing too much air to pass above the grates or an insufficient supply below

the grates; by this statement I do not mean that any particular method of firing will produce any more heat from a pound of coal than nature put into it; just as good results can be obtained from hand firing as have been obtained by the best mechanical means.

It is often the case that firemen are paid insufficient wages for the work they are expected to do. We should be as particular to have good firemen in charge of our boilers as we are in having good engineers in charge of our engine; if we paid the same attention to all the details of the construction and setting of our boilers and their economical use of fuel as we do to our engines, our steam plants would be far more economical. It is just as essential to good economy that the boilers should have the very highest initial or furnace temperature, and the highest possible steam pressure, and the lowest chimney temperature, as it is for the engine to be economical under similar conditions of high initial pressure and temperature and low terminal temperature.

Experiment has proved that bituminous coal requires 150 cubic feet of air per pound; of coal for good combustion an excess of air results in a waste of heat which it carries into the flues and chimney and often a greater loss in an insufficient supply to produce good combustion.

In my experience for steam plant boilers carrying 80 to 160 pounds of steam, I find that at least 20 pounds of bituminous coal should be burned per square foot of grate per hour, and the air spaces of the grates should not be less than 50 per cent. of the grate area; if the grate surface is so large that only 10 pounds of coal is consumed, it would be more economical to reduce the grate surface and burn not less than 20 pounds with good draft, thus securing a good combustion. The same weight of coal burned on a large grate would not be as economical on account of the low temperature; the temperature of the furnaces should not be less than 3,500 degrees, and the ratio of the draft area through the tubes or flues should not be less than $\frac{1}{8}$ nor more than $\frac{1}{4}$ of the grate surface, and the proportion of the heat surface to grate surface should be at least as 35 to 1.

Under the conditions just stated, boilers should be fired very economically whether done by mechanical means or by hand. I have noticed in firing marine boilers on the Great Lakes that the firemen spread their coal evenly over the entire grate at each firing, and they produce steam very economically, while firemen on coastwise steamers will pile up the coal just inside the furnace door, and as it becomes coked will rake it back over the incandescent fire and grate with equally as good but no better results in the way of economy than obtained by the lake firemen; both of these ways of firing are equally good, but in all cases the grate bars should be entirely covered and the amount of air required above the grate should be admitted from above instead of below the grate.

Different grades of bituminous coal require different methods of firing; in all cases he should keep his flues and tubes clear of ashes and soot, as well as his fires and grate bars. In firing anthracite coal, the coal must be spread evenly over the grate in all cases, and, like bituminous coal, must be burned at a high temperature with good draft.

The steam users should see to it that all parts of their boilers and settings should be of equally as good proportions for strength and economy as their engines; employ good, intelligent firemen as well as engineers, and see that both produce good indicator cards.

Mr. D. Ashworth: I have listened to this paper with very great interest, for it touches upon a subject that is the very foundation or the initial point of all proceedings in electricity. The point that is touched upon there impresses me with the fact, in which I think you will all agree, that we have for a long time drifted into the idea that anyone is capable of being a fireman; in fact, we are confronted on every hand with the idea—perhaps in the form of printed matter advocating a certain improved specialty—that no skilled engineer is required. If there is any position connected with the engineering department that requires a fair degree of intelligence, it is that in the fire-room.

Mr. Jarvis B. Edson: There is a great deal to be said upon the question of ignorance in the fire-room, and this is not speaking disrespectfully of the firemen, because it is not their fault. They are capable of being taught and they are appreciative. I speak from personal knowledge. A slight advance over commercial rates, which are considered sufficient for that kind of force, will often be productive of good results, if you will only remember that anywhere from one to 30 per cent. or more of fuel can be easily shoveled into the stacks and up the chimneys, without generating steam. These things are not sufficiently considered by owners of steam plants. We are building some magnificent boilers in this country. They are well adapted for the purpose, and there is no excuse for shoveling coal in them the way we have been doing. On the steamship "City of New York" they have some intermediate dampers near the stoke-hole door, and this shuts off each furnace before the door is opened, thus preventing any ingress of cold air. I think there should be some way found to avoid opening the doors of any furnace; it is wrong to do it, and have a continued contact of the hot with the cold air, which certainly affects combustion considerably. The rapidity with which a door is opened and closed is very important. There are many elements to be taken into consideration by an intelligent engineer. The uniformity of firing is an important matter, as also uniformity of feed water; cleanliness of the fire; the grading of all the operation according to the kind of fuel and the draught and the steam to be generated.

Mr. J. A. Seeley: I thoroughly agree with the gentlemen on the subject of the intelligent fireman; but I would like to know where we are to get him. I think we have had more trouble in the electric light business with engineers and firemen than the mechanical lines have.

Mr. Coggeshall: I would like to ask Mr. Hammond from what depth of fuel upon his grate bars he gets the best results; using either anthracite or soft coal?

Mr. Hammond: About six inches in either case.

Mr. E. F. Peck: We were paying $1.75 a day to our firemen, and we expected them to work 12 hours a day, every day in the year, without vacation. We now pay them $2.25 a day and give them a week's vacation in the Summer. In looking over our records I find that where we were using $2\frac{75}{100}$ pounds of coal per hour per lamp, we are now using $2\frac{51}{100}$ pounds. I do not know whether it is due to improved firing, or whether we have got to a more economic point with our engines. I believe, however, that the additional wages has brought about this result.

Mr. Armstrong suggested that it might be a good plan for the Association to organize a bureau of firing; and then offered the following resolution, which was adopted:

Resolved, That the National Electric Light Association cordially endorses the plan of holding World's Congresses at the Columbian Exposition, and pledges its hearty co-operation to make the Electrical Congress under such auspices a success.

The next business was the paper of Mr. E. F. Peck on "Overhead Construction."

"OVERHEAD CONSTRUCTION."

In view of the great interest taken at present in underground construction, it would seem almost incongruous to agitate the well-worn subject of overhead construction. Still, as the majority of electric lighting companies in this country will have to contend with this method of construction for some years to come, it may be that the subject will still be debatable. There is certainly room for improvement in this direction in many of our cities and towns, due, perhaps, to the fact that it has been the practice of electric lighting companies to cheapen as much as possible this important branch of their work. Then, the material which has been supplied in the past has not been of such character as to permit first-class work; and, rather than stand the expense and loss of time incidental to the manufacture of special fixtures, a great many of the companies have used fittings that were originally intended for the much lighter work of telegraph and telephone companies. The work was also done with a view to the present only; and the rapid increase of business has overtaxed the poles and fixtures, which had originally sufficient carrying capacity. It may readily be seen that this has led to the erection of overhead lines that have, after a year or two of service, become dilapidated, unsightly and dangerous. Then patching was in order, which soon resulted in a tangle and snarl that grated upon the nerves and tried the patience of the central station manager, or superintendent, whenever he had to contend with it. This, briefly speaking, has been the history of the company with which I am connected, and is, no doubt, the history of many of the companies represented at this Convention.

How can this state of affairs be remedied? In order to answer this question as briefly as possible, and, at the same time, to bring out a discussion that will, I trust, prove both interesting and instructive, I will outline some recent work that has been done under my supervision in Brooklyn.

We had reached that point where further patching was out of the question, and reconstruction became a necessity. The first point of attack was our switchboard. This was the old style plug, socket and cable board, with wooden framework, originally designed for 36 circuits and 36 dynamos, but now, due to the increase of our business, handling 53 circuits and 42 dynamos. I will not dwell long on this subject, as I understand that an exhaustive treatise on switchboards has been prepared by one of our members.

The switchboard that I have planned is arranged to manipulate 80 circuits and 66 dynamos, divided into three units, which I will describe as sections A, B and C—circuits and dynamos in each section being interchangeable—section A to provide for 32 circuits and 22 dynamos, and sections B and C each providing for 24 circuits and 22 dynamos. Each section consists of two rectangular slate slabs, placed five inches apart, supported on a suitable framework of steel I beams and channel bars, occupying three sides of a square. Into these slabs are fitted rows of metal bushings which are properly connected together by copper strips, so that the horizontal rows of bushings on the front board are connected to the dynamos *via* single throw jack knife safety switches, while the vertical rows on rear board are connected to the circuits and also to an extra row of bushings on the bottom of front board. This extra row is used to connect two or more circuits together by means of cables and plugs, the connecting of dynamos to circuits being done by means of an ordinary plug of brass tubing, provided with an insulated handle. Above the switchboard proper, which stands about five feet high, slate slabs extend to the ceiling of the room in which the board is located, providing space for necessary lightning arresters, combined ammeters and polarity indicators, to be used on each circuit.

The next improvement which became necessary was the building of a suitable wire tower. The wire tower of a central station is an unknown quantity and a problem that is hard to solve. The first question is as to its shape. Shall it be rectangular, octangular or circular? This can only be answered by one having a thorough knowledge of the situation of the station and the directions which the circuits are to take after leaving the same.

While at Montreal, I saw a very pretty arrangement of a wire tower on the new station of the Royal Electric Company. It was octangular in shape, each side being about ten feet wide, with a rectangular section of slate framed into each section. This permitted the introduction and insulation of wires without other precautions, and, owing to the shape of the tower, provided for a lead for the circuits in eight directions. In our Brooklyn station, it was necessary to have the wires leave the tower in one direction only; so it was built rectangular in shape (see Figs. 1, 2 and 3). The tower is built directly over the switchboard and is 23 feet long and 10 feet wide. The framework of the tower, inside wire rack and outside wire rack, are all framed and bolted together, and guyed to the roof in the rear of the tower by means of wrought iron rods, provided with turn-buckles. The front, or side through which the wires enter, is made up of two thicknesses of two-inch plank laid diagonally to each other and fastened together with wooden pins. This was done to insure sufficient strength without framing and to permit the promiscuous boring for glass bushings. The inside finish of the tower is of hard oil varnish, and the outside of three coats of insulating and fire-proof paint. The roof is of slate, the eaves of which extend over the outside rack, thus, to a certain extent, sheltering it from the weather. At the bottom of the inside rack of the tower is an auxiliary slate switchboard of very simple construction, consisting of two rows of metallic bushings and binding posts. By the use of plugs and cables on this board the tangles and cross connections, incidental to all central stations are confined to this particular point. This arrangement also permits the transferring of circuits to any one of the sections of the main switchboard, thus adding to the flexibility of the entire system. From the outside rack, the wires are carried to a distributing pole (see Figs. 4, 5, 6 and 7) of Norway pine set directly opposite the center of the tower. This pole is 92 feet long, 30 inches in diameter at the butt, 18 inches in diameter at the top, and is set 12 feet in the ground to insure stability. This height was necessary to allow wires to clear a three story building to be built in front of the wire tower. On this pole are fitted 11 double sets of eight pin arms, and 11 double sets of 16 pin arms, a total of 44 arms, providing for 176 wires, or 88 circuits. The 16 pin arms are set parallel to the arms on the tower rack, and the eight pin arms are at right angles to same, to enable wires to run north and south. These arms are of the best quality of long grained oak of the following dimensions: Eight pin arms are eight feet long, three and three-quarters inches by four and one-half inches, pins nine inches between centers—excepting pins nearest the middle of arm, which are three feet between centers, to allow a man to pass between wires when ascending the pole. Sixteen pin arms are ten feet six inches long, four inches by five inches, with pins six inches between centers. The pins used on these arms are of selected locust, one and one-half inches in diameter, and the glass insulators are of the deep grooved double petticoat pattern. The bracing and fastening of the arms can best be seen by referring to the sketch.

From this point, the poles gradually decrease in length until a height of 50 feet is reached, which height is maintained on all our main lines. On lines carrying from eight to 16 wires octagonal chestnut poles are used, 35 feet long, 10 to 12 inches at butt and six to eight inches at the top. Lamp poles are of the same material and shape, 24 feet long, eight inches at butt and six inches at top.

Particular attention is paid to the guying of poles where necessary; and we are using for this purpose four No. 6 B. & S. galvanized iron wires twisted together to form one strand, and introducing turn-buckles on all main guys. This wire is purchased made up in this manner, and we find it a great improvement and saving over the old method in vogue, of allowing linemen to waste their time in making up guys as needed.

While on the subject of poles, I wish to call attention to what I consider an erroneous method of treating poles to preserve them which is practiced by many companies. Pitch or tar is applied to the butt, thus confining the sap, which ferments and hastens decay.

There are many different ways of treating poles, but I know of no method which is successful unless applied to the entire pole. The well-known creosoting process is objectionable on account of the dirt and the unpleasant odor connected with it, as well as the fact that the creosote does not penetrate to a sufficient depth. The same objections apply to the Burnettizing and Kyanizing processes.

My attention has been recently called to the Haskins process, which seems to be highly successful. This process consists in the placing of timber in an air-tight retort and subjecting it to the heavy pressure of superheated air, which permeates the whole section, thereby accomplishing the same result as a charring process, without losing any of the chemical properties of the wood.

In regard to the character of wood to be used for poles, the choice is limited in the vicinity of New York, those obtainable being chestnut, Norway pine, Princess pine, cedar, yellow pine, spruce and white pine. The Princess and Norway pine, although not as durable as chestnut, are the most desirable for the heavier poles, on account of their straightness and size. For lighter work, I prefer hewn or sawed chestnut poles to all others, and they are still obtainable in lengths up to 40 feet. Cedar poles are excellent as far as life is concerned, but too crooked and knotty to be useful for first-class work. My experience with yellow pine, spruce and white pine has been very discouraging, the life of each being short and uncertain.

The next step in the way of improvement which suggested itself was a better method of hanging commercial lamps. It has always been a source of surprise to me that more attention has not been paid by lighting companies to this important matter. The small additional expense necessary to ornament these fixtures certainly ought to warrant an improvement. I have shown in Fig. 8 a fixture adopted by us which is not expensive, but neat in appearance, and it allows of a substantial method of wiring without the use of other appliances.

The fixture is made of wrought iron pipe, excepting the flange or T, which is of cast iron.

In Fig. 9 I have shown what is possible in the way of an ornamental fixture. The scroll work in this fixture has been arranged to permit the introduction of the initials of the firm (S. G. & Co.) in front of whose store it is placed. The scroll letters are gilded, while the remainder of the fixture is black. The effect is both pleasing and attractive.

Last in the line of improvements came the wiring. It was only a question of rubber covered wires *versus* weather-proof. We compromised the matter by using the best grade of rubber covered wire for all leads from the switchboard to the main poles, and on all lines crossing under telephone and telegraph or uninsulated wires. For the balance of the reconstruction the best grade of weather-proof wire was used. It will be noticed that I have used the term "best grade" for both classes of wire. This term is a little ambiguous, as I am reminded each day by our friend, the wire salesman, who claims that his brand of wire is the best and that all other kinds are not in it. So it remains for the purchaser to judge for himself as to the respective merits of the different brands in the market.

On some of the loops to buildings, where two or more circuits were necessary, we have used, with great success, duplex cables, thus doing away with a complicated and unsightly network of wires and fixtures. All wires are run on deep groove double petticoat insulators, the use of rubber hooks and porcelain knobs being avoided. It would be difficult to formulate rules for this branch of construction, it being simply

a question of judgment and experience. However, a few suggestions may not be amiss. Great care should be used in the stringing of wire, for the insulation of a whole circuit may be ruined by the carelessness of linemen in handling. Joints should be soldered on all electric light work when possible. I have found that wrapping a joint with tinfoil, and then covering with a good rubber tape, makes an excellent substitute for soldering, and is easily applied. Keep wires on the same relative pins to the end of the line, thus avoiding confusion, and making it an easy task to locate trouble. Diagrams of principal poles, showing location of circuits, should be kept in every central station, for they are often the means of preventing serious trouble. Do not leave loops up that are out of service, expecting to pick them up again, as they may become a menace to your live wires. If more attention were paid to overhead construction by the electric lighting companies, substantial, neatly-painted poles being used, with well-insulated wires kept taut and thoroughly inspected, the everlasting hue and cry against the "deadly" electric light wires would soon change to one of commendation and praise.

The Vice-President called upon Prof. Elihu Thomson to open the discussion.

Professor Thomson: I have not given the subject of overhead construction much thought, except that the problem has always been with me since we started in the work. I have always been of the opinion that a well constructed overhead line—every detail studied as are other problems—every change of direction made with reference to permanence and sightliness—would do away with a vast amount of the objections which the methods in vogue have given rise to. I noticed the paper stated that, instead of soldering joints, tinfoil may be used. That may possibly work for such circuits as arc light circuits, for the reason that, although the tinfoil is not to be relied upon as making the connection, it would undoubtedly act as a kind of sealing agent to keep the elements of corrosion away from bright copper. I think a great deal can be done in the way of the fittings of lamps in the streets. Abroad this matter has been, perhaps, better understood than here. Our desire in the past has been to get into business as soon as possible. It should now be our desire to get our business in as good trim as possible, and make it as permanent and attractive as possible. Abroad the habit is to put up light ornamental poles for the arc lamp, and some of the designs are really elegant and not expensive.

Mr. Seely: I think there is only one way of making a joint, and that is twisting it with some kind of a sleeve. I have tried the tinfoil, and I find in using it the linemen are not careful with it; after it is put around the wire, in tapping it, it is often abraded, which opens the seams of the foil. A soldered joint is preferable, I believe.

Mr. Peck: In regard to using tinfoil on a joint, I did not mean to have it understood that I recommended its use. I simply spoke of it as one method of making a joint, when it was not easy to solder. We sometimes have orders come in at three o'clock in the afternoon and the party wants the light at five, and we are obliged to cut into our lines and make a quick job; and when it comes to take a solder pot, and all that, we haven't time. I only intended to speak of it as one method, being a little better than a common joint, with simple tape. The tinfoil will protect the joint from the effect of the rubber and is better than a plain joint.

Mr. Seely: I wish further to state that I believe it is entirely a mistake to erect large poles. An 80 foot pole is liable to break in heavy storms in Winter, and surely we are carrying more weight with a copper wire on a pole than the small No. 12 wire used on telephone poles. I think the average pole should not exceed 50 feet in height. I see very little use in protecting poles in the earth with any substance whatever. It is an expensive luxury.

Mr. Peck: In regard to the height of the poles, I do not recommend high poles. In Brooklyn we are obliged to run our main lines over a street which has a elevated structure and with a number of stations all along the line which we have to jump over, and it is neccessary to use a high pole. On all our other lines we use a pole from 35 to 50 feet. I like a pole about 40 feet high.

Mr. Wightman: I should like to ask Mr. Peck if he can tell us anything new in regard to their method of locating open circuits on the line. Have you any method calculating where it is?

Mr. Peck: We have no system any more than the ordinary method with the magneto bell. At night-time our inspectors use jumpers. I know of no invention practicable for locating open circuits.

Mr. M. D. Law: My system was to use an arc light machine on independent power. If you have not an arc light machine of independent power, it would perhaps be well, if you have a large number of lines, to provide a small dynamo. In the location of gounds, on all arc light circuits, I use a bank of incandescent lamps in series of the same voltage as arc light lamps, 50 to 52 volt lamp is about the proper thing, using about five more lamps than you have lamp capacity for in your dynamos. These lamps are coupled in series, with the wire leading from each lamp to a switch, using a circular switch, so that it may be moved to cut out 1, 2, 3, 10, 25 or 50 lamps, as the case may be. By connecting one side of this lamp bank to your circuit, say the positive side, and the other side of the lamp bank to ground, you will either have your lamps burning at full candle power or perhaps not showing anything. Then immediately turn on or turn off these lamps until your lamps are brought to their proper potential or candle power. Now if you have 10 lamps burning on your positive side, then go on to the negative side and go through the same process. If you have 60 lamps burning on your circuit, and you only have 10 lamps burning on the positive side, your ground lies between these two points, and you have the location. I have invariably been able to settle the point within one or two lamps. This is a great advantage when you are in a hurry, and a circuit of 10 or 15 miles, and generally have start on the wrong end, as is the case, nine times out of ten, in the other methods. We have a machine running at slow speed—a definite speed of about 300 revolutions, from which you will get a spark an inch and a half or two inches long; and still not sufficient, if a man gets caught, to do him injury.

Mr. Stanley: I believe every gentleman here has been interested in the possibility of putting his wires underground and I have found that it would not be remunerative for us to put our wires underground until we had found a system which would displace 20 wires above ground for one underground. This is about the ratio it works out at. With that means, in the case of an arc light circuit, you would put 20 times as many arc lights on one circuit, by some means unknown at present; and you would have to use at least five or six times the potential on the alternating circuit. Power stations would have to carry 20 times increased power before, in my judgment, underground service can be useful.

Mr. J. E. Lockwood: Mr. Law has suggested that a dynamo, either running slow, or, as probably would be the case, running at full speed and regulated to give only a small amount of electromotive force, be connected with the circuit so that a lineman could go out and by grounding the circuit at different points, tell when he passed a break, by failing to get a spark. I think that is an unsafe method. I know of a case where it was fatal. I believe the magneto bell answers the purpose fairly well. If it is done with a dynamo the order should be imperative to the man in charge of starting the dynamos, that the man sent out to locate the break is the only man to give the word to start.

Mr. Law: In answer to Mr. Lockwood, I would say that my orders are imperative; that no dynamo should be run above a certain speed. The man who goes out on the trouble informs himself as to the manner in which the dynamo is running before he starts. I have handled this system for over 10 years and have had innumerable open circuits and have never had a man injured in any way. A magneto bell is not to be relied upon in a test of this kind. I was out the other day with a magneto bell. There were heavy grounds on the circuit, but there was force enough to ring the bell and it was impossible to hunt up the open circuit. I never had that difficulty when I used the dynamo. If you are positive, and your orders are obeyed at the station, there is no danger of any man being injured.

Mr. E. A. Leslie then referred to the self-induction of overhead wires, particularly when not strung on the poles in such manner as to neutralize each other, and quoted a number of tests recently made on his lines in New York, showing that in the case where a proper arrangement of the wires on the poles had been neglected, the apparent resistance of the circuit was 60 per cent. higher than in the case where this matter had received attention.

The paper on "Operation of High Tension Currents Underground," by E. A. Leslie, was then read. Also the paper on "The Underground Construction of the Buffalo Railway Company," by J. B. Craven.

"THE OPERATION OF HIGH TENSION CURRENTS UNDERGROUND FROM A PHYSICAL AND FINANCIAL STANDPOINT."

The underground conduits in New York city for high tension currents are owned by the Consolidated Telegraph and Electrical Subway Company, who lease their ducts to the various electric lighting companies. The prevailing type of duct is of iron pipe, mostly three inches in diameter, running along the sides of the streets into manholes about 275 feet apart. These are the so-called "trunk ducts." Over the trunk ducts are superimposed from two to four distributing ducts, with four-way handholes about 50 feet apart. Many of these handholes are brought to the surface of the street and are covered over with an iron plate, which is easily removable, giving ready access to the wires in the distributing ducts. In many places, however, the handholes do not approach the surface, and, in order to get at the wires to make changes or connections, it is necessary to dig up the street. Again, on some of the prominent streets no distributing facilities whatsoever have been provided and the companies are compelled to make long and expensive house connections from manholes. This is particularly true of Sixth avenue above Eighteenth street and Broadway above Thirty-fourth street.

The Subway Company have also a number of miles of a system which is made up of sectional iron castings and so framed together as to combine in one conduit both trunk and distributing facilities.

These conduits have no surface handholes and, in order to make changes or connections, it is also necessary to dig up the street. The manholes are about 275 feet apart as in the case of the iron pipe.

There is also a small amount of conduit in use, which is composed simply of cement-lined iron pipes, running from manhole to manhole, of about three inches inside diameter.

The cost of the New York conduits is an unknown quantity. The Subway Company guard the secret well, and, beyond the general statement that they have cost, on an average, nearly $5,000 per mile, per duct, no reliable information can be gained. In these figures, however, are doubtless included the expenses of years of legislation and long and costly litigation. It is the universal opinion among electric light men in the city that the actual average cost should have been less than $3,000 per mile of duct.

The companies with which I am connected use, principally, cables insulated with a rubber compound, although we also have in use 35 or 40 miles of cable, the insulating material of which is fibrous.

Underground conductors cost from four to five times as much as overhead conductors, which is a matter to be carefully borne in mind.

The manner of laying cables is simple. It is first necessary to draw a rope through the duct to be occupied. To do this, rods about three feet in length are used, having brass male and female screw attachments, one at each end. The first rod is inserted in one end of the duct; then another is screwed into it and pushed forward, and this process is continued until the first rod emerges into the manhole at the other end and you have an unbroken line of connecting rods through the duct. A rope is then attached to the last rod, and, as the rods are pulled forward and unscrewed in the manhole at the distant end, the rope is gradually drawn through. Unless a large number are to be drawn into a single duct, they can be drawn by hand without any special machinery. If, however, it is desirable to draw in as many, at one time, as the duct will hold, it is necessary to use a winch or windlass, or, in lieu of either, a snatchblock with a rope and tackle, and enough men to pull the mass. Great care should be observed not to allow the cables to twist in the duct, as, if this occurs, it is next to impossible to withdraw any given conductor thereafter without removing all conductors in the duct. In cutting the cables to fit given sections, about 12 feet should be allowed for slack between manholes, for racking around the sides of manholes and for metallic joints. The cost varies considerably. To draw in two cables in a duct would cost in the neighborhood of from 2½ to 3 cents per foot of cable; but to draw in four or six, or even eight, as has frequently been done, the cost diminishes and will not average over two cents per foot, or even less, assuming that the men in charge have had experience and understand their work thoroughly.

The proper jointing of cables is a matter of paramount importance. Unless the joints are made by an experienced person, it is almost impossible to secure a joint which will give the same insulation resistance as the cable itself, and yet, unless the joints are so made, the object of securing immensely high insulation in the cables proper is entirely defeated and a large proportion of the original investment practically wasted.

The New York Subway Company, in its early inception, framed a set of rules governing the operation of underground conduits. Among them is one which has always challenged my admiration and the man who framed it either built wiser than he knew, or was a remarkably gifted person. This rule at first was considered absurd and impossible of compliance, but to-day I think I am safe in saying that every electric light company governed by it will acknowledge its wisdom and admit that, by having enforced a high standard of insulation from the very outset, a large amount of subsequent experiment and waste of money has been avoided. I quote the rule:

Section 4. Electromotive Force.—"All conductors drawn into and operated in the conduits, and intended to convey currents of an electromotive force exceeding 100 volts, shall have at the temperature of 75 degrees Fahrenheit, an initial insulation resistance of not less than 15 megohms per mile per 100 volts electromotive force of current in the circuit. Whenever the insulation resistance of a conductor as aforesaid shall prove to be less than five megohms per mile per 100 volts, the use of that conductor shall at once cease, unless the actual electromotive force in its circuit be reduced so as to re-establish the foregoing ratio."

You will observe that the initial tests of cables laid by any of the companies in New York city must show an initial insulation resistance of not less than 15 megohms per mile per 100 volts of current used. This means that, with an alternating current of 1,000 volts, the cable must show, before the current is turned into it, to have an insulation resistance of not less than 150 megohms per mile, with an arc circuit of 2,500 or 3,000 volts, or even 4,000 volts, initial insulation resistance must not be less than 375 megohms, 450 megohms and 600 megohms, respectively. Taken into consideration with the fact that on an ordinarily humid day, overhead circuits will not show an insulation resistance of more than from 200,000 to 500,000 ohms per mile, the above requirements seem altogether impossible of attainment and to be ideal rather than practical, but this is not the case. On the contrary, it is rare, indeed, that the initial tests of cables laid in New York city do not show from three to four times the initial insulation resistance required by the rule, and, of the hundreds of miles cable actually in operation at the present time, and which have been in operation from two to three years, and with which I am personally familiar, I do not believe that there is one that will not show, under like conditions, nearly, if not quite the same high degree of insulation, as when the original test was made.

The first cable laid by the Manhattan Electric Light Company on Broadway was insulated with rubber compound and the joints were made by contract, on the representation of the contractor that his men were professional jointers. After the cable was connected throughout, a test showed less than a megohm of insulation per mile, and this bad condition of things was quickly shown to be in the joints; every one of them had to be cut out and our lesson was well learned. Since that time we have never allowed any but our own men, specially trained and educated for the purpose, to make joints on rubber compound cables. I once wrote a gentlemen regarding joints, that, in making each and every one of the thousands of joints in use, we have observed in every case, the same care and precaution in making them as is observed by the Atlantic Cable Company in repairing breaks in mid-ocean, where, in such cases, it used to be the custom, before they maintained their own ships, to charter or equip a vessel to reach the locality of the break, the cost of which ran anywhere from $40,000 to $60,000, and where this whole sum was dependent upon the making of one first-class joint. This may sound like an exaggeration, but, nevertheless, I can assure you that our extraordinary precaution has saved us an unknown, but large amount of trouble and, on that account, our almost total immunity from interruption is largely due. The cost of joints will run from $2 to $3 apiece and any manufacturer can give proper directions how to make them and what to use, both as to metallic contact and insulation, but, in the case of the rubber compound cables, the difficulty lies more with the man than with the method. Men whose hands are naturally moist cannot make a good joint, *i. e.*, a joint which will test "infinity."

We are required to test all underground circuits at least once per week. For this purpose a portable reflecting galvanometer is used. Where the cables enter the station a test room, free from the jar of the building, is usually provided in which to set up the instruments; but, in cases where the cables are reached from the station by overhead wires, it is customary to rent a quiet room adjacent to the junction-pole and connect by a well insulated "lead" for permanent use. The total insulation of a circuit with all converters or arc lamps connected, will generally fall below the requirements of the rule above quoted, but, unless it is shown to be less than, say, one megohm per mile of cable, its condition, as a "completely connected circuit," is usually accepted. But, as a general rule, when the insulation falls below this standard, what are termed "ex-converter" and "ex-lamp" tests are called for. These require, in the case of incandescent circuits, that every converter installation be cut out, the cable ends freed from all contact, and test of cables only be made to ascertain their exact condition. The arc circuits are similarly treated by disconnecting all lamps and switches. Unless the results of such tests come within the limit prescribed by the rule, the circuits are not allowed to be operated until the defect has been removed and the insulation brought back to the required standard. Fortunately, defects are rare, and tests of

this character are not now called for with sufficient frequency to prove burdensome.

House connections are built by the Subway Company at the expense of the electric light companies; but the Subway Company claims not to relinquish ownership therein and will not allow their joint use by two or more companies, except by special arrangement. The cost of house connections in New York city is appalling to the man of exclusively overhead experience.

Fortunately, it often happens that one house connection will serve for two or three different installations, and, in this way, the average cost per installation or per arc lamp is very largely reduced. For instance: In the Fall of 1890 our arc lamp connections cost us, on an average, only $43; in the Spring of 1891, an average of about $30; the ratio of new connections to new installations or lamps being as one is to two. In other words, for 100 installations or lamps we were required to make but 50 house connections. This ratio could be largely and safely reduced were we allowed by the authorities to use more than 100 feet of overhead wire with each underground connection.

It is a fact worth knowing that the underground service is more reliable than that of the overhead. Storms, blizzards, sleet and wet snow have little or no effect upon it, and neither has lightning, where the circuits are entirely underground. In consequence, cases of interruption are rare; crosses never occur; grounds but seldom, and open circuits are unknown, except when a break occurs at a lamp or a switch.

The number of "burn outs" in the subways is small, and thus far, after three years' experience, not a single instance of burn-out has occurred in our "rubber" compound cables that has not been directly attributable to some imperfection of manufacture, which originally escaped detection, or to mechanical injury after the cables were laid. And these have not amounted to more than 10 or 12 all told. We have, however, had several instances with the "fibrous" compound, but whether due to accidental abrasion of the lead covering, which is fatal to that form of insulation, or to some inherent defect, we were unable to determine, as the intense heat of the escaping current destroyed all evidence in each case.

During the first year of our experience we suffered considerably from mechanical injuries caused by the carelessness of employés of other companies having common access to the manholes with ourselves, and I presume our own men were equally culpable as regards the property of our neighbors, but the common experience of the companies suggested greater care and consideration upon the part of all, and, by carefully stowing the cables away upon racks built along the sides of the manholes, mechanical injuries have now be come exceedingly rare.

On wet nights we have an occasional case of trouble in a leaky switch-box, or at an exposed joint, where the wire running to the lamp is connected with the cable. These joints were at first covered with ordinary tape, but after a few months' exposure the tape would invariably leak under the high pressure and sometimes convey the current to the lead covering and result in a burn-out.

In the case of rubber compound cables, we now simply cut back the lead a few inches, strip off the taping, make an ordinary metallic joint and then slide over the bare metal a floor insulator, open at both ends, and standing upright so as to allow the rain to run through the lower end; the insulator resting upon the rubber compound, not upon the lead covering of the cable. This, of course, refers only to lamps where switch-boxes cannot be used, such, for instance, as city lamps. Where fibrous cables are used, a regular insulating joint of pure rubber is made, connecting to a short piece of specially insulated wire. The joint is immersed in boiling hot paraffine and the specially insulated wire is then connected in the ordinary way to the wire running to the lamp. This is done to protect the insulation of the cable from moisture and also to facilitate connecting and disconnecting with the lamp, which the regulation tests frequently render necessary.

In laying cables it has been found desirable to place both "legs" of incandescent circuits in the same duct. When they are separated into different ducts great loss results from self-induction.

The use of the subways makes it possible to employ much heavier single conductors than could be used overhead. There are in some of the ducts conductors having nearly, if not quite, 500,000 circular mils area, and such sizes as No. 00 and No. 0000 are quite common. The conductor being composed of small wires stranded, affords sufficient flexibility for all purposes; but in sizes up to and including No. 2 B. and S., the conductor is generally solid.

In the matter of public safety, the records of the past three years show but one death to have occurred from current conducted underground, and that particular case occurred on top of a city lamp-post on a wet night, the victim neglecting to use his gloves. Prior to 1891, deaths caused by shock from overhead wires occurred with considerable frequency—sufficiently so to arouse great public excitement and hasten the burial of the wires underground. But it is fair to state that more than nine-tenths of all the accidents were primarily due to the inferior character of the overhead construction and the extraordinary multiplicity of wires of all kinds in the streets.

A good system of underground conduits fairly covering the electric lighting territory of a large city, will, in my opinion, cost on an average from $2,500 to $3,000 per mile per duct, but, in the case of a single duct in a trench, the latter figure is likely to be exceeded, depending largely upon the character of the digging and the engineering

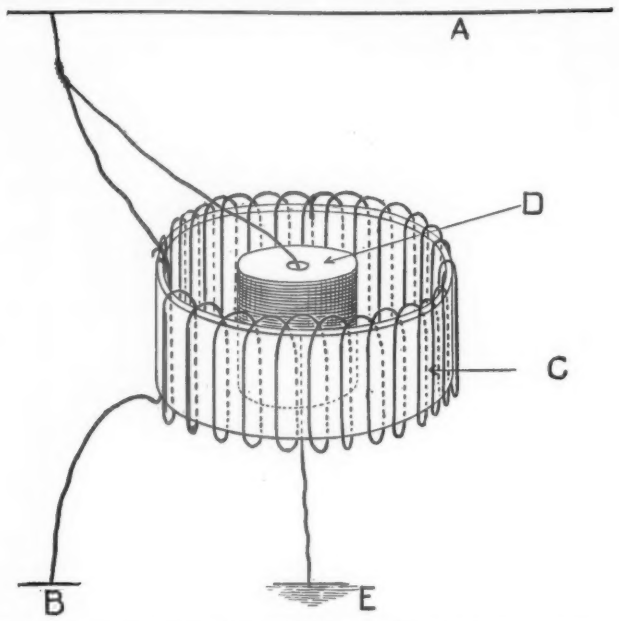


FIG. 1.—UNDERGROUND CONSTRUCTION BUFFALO RAILWAY COMPANY.—LIGHTNING ARRESTER.

difficulties to be overcome. For the purpose of comparison, however, let us assume $3,000 to be the cost of one mile of distributing duct and then consider the cost of one mile of construction for one arc and one incandescent circuit, by both underground and overhead methods, as follows:

UNDERGROUND.	
Duct, - - -	$3,000.00
11,000 ft. No. 4 cable at 20 cents, laid, - - -	2,200.00
11,000 ft. No. 2 cable at 30 cents, laid, - - -	3,300.00
40 house connections at $75.00	3,000.00
Total, -	$11,500.00

OVERHEAD.	
50 poles prepared and set at $12.00,	$600.00
11,000 ft. No. 4 wire, at 4½ cents,	495.00
11,000 ft. No. 2 wire, at 7½ cents,	797.50
40 house connections - -	480.00
Total, -	$2,372.50

Hence, from these figures, it must be assumed that the initial investment for an underground system will exceed by about five times the cost of an overhead system, and the fixed charges on this very expensive feature of investment in a central station plant must be correspondingly increased.

But in New York city, as before stated, the underground conduits are owned by a subway company, who have an exclusive franchise and who lease their ducts to the various electric light companies upon the following schedule of rentals:

Distributing Ducts,	$1,000	per mile,	per an'm
Trunk Ducts, 3 in.,	900	"	"
2½ "	800	"	"
2 "	700	"	"
1½ "	550	"	"

These rates have the effect of increasing the usual and ordinary expenses of a central station enormously, and, although some overhead wires are still in service, and our field of operation is almost wholly confined to the more important streets and avenues, *the amount of the duct rental already equals the combined cost of coal, water, oil, waste and the salaries of chief engineer, engineers, firemen, coal handlers, boiler cleaner and oilers employed in the engine department.*

While I have no complaint to make against the Subway Company of New York, I know that the subways could be operated by the companies for much less money than they are now required to pay, taking into full consideration the matter of interest on capital investment, cost of maintenance and operation, and every other charge which can be justly considered. Therefore, for those to whom opportunity is yet given, it might be wise and prudent to at least secure the right to construct underground conduits, even although they may not adopt their use for some time to come.

As to maintenance, our experience with cables has not been sufficiently great to give us a definite idea as to their possible life. Aside from this, however, it costs no more to maintain the cables than it does to keep overhead wires in good order, say, from $15 to $20 per mile per annum—probably not quite so much; but, unless the cables last at least 20 years, the cost of maintenance is also likely to be far greater.

Finally, summing up the whole situation, the following conclusions may be fairly reached:

First. The underground service is not only a physical possibility, but an established fact upon a very large scale.
Second. It is less liable to interruption than overhead wires.
Third. It is less dangerous to human life.
Fourth. Its cost is enormously greater.
Fifth. It is cumbersome to a degree and lacks, to a considerable extent, the flexibility of overhead wires.
Sixth. Its cost precludes its extension to sparsely lighted districts, which must either be reached overhead or permanently abandoned.

"UNDERGROUND CONSTRUCTION OF THE BUFFALO RAILWAY COMPANY,"

BY J. B. CRAVEN.

Underground construction for railway use is becoming every day a more prominent feature of railroad construction. Overhead mains and feeders will not much longer be tolerated, especially in the larger cities, where already the common councils are making it part of a railroad franchise that feeders, at least, shall be buried. The trolley wire, being bare, is of necessity left overhead, as safer and more economical, but it behooves us to meet this popular demand of placing all wires possible below the surface, otherwise we may be compelled to put the trolley wire itself there. Such an order would put the electric railroad industry back for quite a number of years, for not only would it be expensive, but, to my knowledge, no commercial underground trolley system has yet been put on the market.

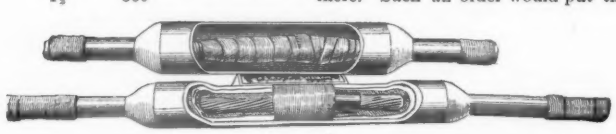


FIG. 2.

Underground construction for railroad use brings us many problems to solve. Whilst not using a high tension current, we have one side of our system always grounded, so that between the many miles of cables in use and the earth we have a difference of 500 volts; thus you see at once the necessity of having and keeping up the highest insulation possible. This question of ground returns requires that the insulation resistance of a railway circuit be twice that of an arc or incandescent underground system, where you have a metallic circuit; then there are the constant and excessive strains that one does not meet either in arc or incandescent lighting, due to the throwing off and on of the cars. It is almost impossible to figure your feeders to carry the maximum current, so that at any time you are liable to have your cables overloaded, bringing very heavy strains upon them.

Another question is the one of connecting overhead with underground wires. This brings lightning to the field to be guarded against, for the large surface of trolley wire offers an attractive path for lightning, and how to protect the underground feeders and mains has been quite a problem. Lightning has little regard for insulation, seeming to want a path only to earth; this path is offered by the underground cables, so that we have to introduce some arrester at the junction of the underground and overhead wires to give it some other path.

Fig. 1 shows by what means we hope to accomplish this end. A is the overhead conductor, B is the underground cable to be protected, D is a non-inductive path to the ground, C is a coil with an iron core grounded through a fuse. This you see will offer two paths to the lightning; one of very low resistance to the dynamo current, but very high resistance to a lightning discharge, due to its self-induction, the other a very high resistance to the dynamo current, but a very low resistance to the lightning discharge.

This arrester is placed inside a water-tight iron box on top of a pole, wherever tap is made with overhead wires; this box also affords a good place where overhead and underground wires can be connected and keep moisture from the cables; this is accomplished by wiping a three inch lead cup onto the lead of the cable and filling it with insulating compound.

We have in this city about 11¼ miles of subways, divided into two trunk lines, which branch off, carrying feeders to the outlying districts. Our conduits are laid in cement, 30 inches below the surface of the street. They are crowned in the center, so that the water will drain to the manholes, which in turn drain to the city sewers, with a bell-trap to prevent sewer gas coming back.

Lately, on account of natural gas finding its way into subway and manholes, we have found it necessary to attach a blower at the station, which ventilates the whole system. Manholes we have placed every 400 feet, and have tried to make that distance standard, as pulling a greater distance brings an excessive strain on the cable when drawing in.

After careful consideration before this work was started, we decided to depend on our cable for insulation, not on conduits made of insulating material. To me it seems impossible to prevent moisture from penetrating the latter system, thereby lowering the insulation. We depend on our ducts for mechanical protection alone.

The cables in use here are lead-covered, provided with an exterior fibrous jacket or covering saturated with pitch, the purpose of which is to protect the cables whilst being drawn in the duct. We have some 45 miles of cables, which have been in use since July last. These are of two classes—one for insulation depends on pure Para rubber, the other on a composition, our shortest feeder being two and a half miles in length, some of the longer ones reaching a distance of eight miles, yet the insulation on none at the present day is below 120 megohms, the short ones testing as high as 1,100 megohms. In laying this cable all tests were made in the testing-room at the station; this was made feasible by the use of a telephone circuit throughout the underground system, so that a workman making a joint in a manhole was in communication with the man making the test and could always find out if his work was satisfactory. The joints made were the standard joints used by the companies from whom the cable was bought. A cut of these will be seen in Fig. 2, the lower one being the one used for the rubber covered cable, showing the consecutive layers of insulating tape; the first, which is next to the copper, being a narrow white tape, free from sulphur; then follows a layer of pure Para rubber tape; upon this is wrapped a layer of rubber compound, then a layer of black rubber, and around the whole is wound cloth tape of a sufficient thickness to entirely fill the lead sleeve; the ends of the lead sleeve are then dressed down and wiped to the lead covering of the cable with an ordinary plumber's wiped joint.

The upper cut represents a joint as made in the cable, using composition for insulation; the method here employed differed from the foregoing in that the lead sleeve is slipped over the completed copper joint, dressed down and wiped, the sleeve then being filled with compound through two small holes tapped through the top which are afterwards closed permanently with a soldering iron; each feeder, for the purpose

of tapping off branches to feed the trolley wire and to facilitate the breaking of cables in case of trouble, is run through a junction box (Fig. 3) every 1,000 feet. The box shown in the cut has eight stubs, which allows three cables to pass through and be broken, and two taps to be taken off for feeding purposes.

A small telephone box is seen at the left. One of these is placed in each manhole, the terminals of which are all in multiple. A few words in regard to the testing of this system and the difficulties encountered on account of one side being grounded.

We are obliged to test at night, when the load can be thrown off one feeder and onto another; then it is disconnected by means of a switch where it connects to the overhead, and the test is then made. It is rather a slow process, but the only one left open to us.

Fig. 4 gives a general idea of the testing-room, which is equipped with first-class instruments for practical use. The galvanometer, which is of the Thomson reflecting type, is enclosed within a magnetic shield made of wrought-iron pipe, and also suspended by three springs to absorb vibration. The rest of the instruments consist of a chloride of silver battery, standard resistance and shunt and reversing key. To the left is seen the telephone communicating with the manholes.

Thus far we have looked upon the difficulties and disadvantages of the underground system. No arguments have been advanced in its favor, but I think you will agree with me that it has some. First, it does away with the public objection of disfiguring the streets, obstructing firemen in their duties, and, in the case of high tension currents, a menace to life itself; and then the liability of wires falling, causing a suspension of traffic, and, in case of a storm, causing a delay and loss of thousands of dollars to the company themselves.

Mr. Armstrong: I wish to say a word on these papers from the standpoint of a citizen only. I am glad we have this admirable paper on the New York subways. It speaks volumes, and it is fortunate for us that we can put this matter before the public. While there are advantages in these underground systems, yet the chief one seems to be from an æsthetic standpoint. We gain all the practical advantage possible under the present system, and it is only a question for the public whether they will put an enormous sum of money into these subways—for it is the consumer that must pay for it—or whether they will put it in their pockets. Not one out of ten companies could live if they had to go to expense of putting the wires in these subways at the enormous expense which it entails.

Mr. A. G. Brown: The subway law of New York city was passed initially for æsthetic purposes only. The question of safety or non-safety was not considered to any extent. With the enlargement of the electric light business and the putting up of a large number of wires, complications arose between the electric light wires and the telephone and telegraph wires, and this aroused a sensation calling for the putting down of the electric light wires underground.

The agitation of the underground question was taken up by the press, and the commission would order a number of subways to be built in the street, regardless of the requirements, for telephone, telegraph, and electric light wires. In one case (Third avenue) they have 20 ducts built for a distance of 12 miles, from the City Hall to the Harlem River, and there are probably not four occupied for the whole distance, and at no place more than 11. This is true, to a great extent, of the electric light wire subways, the fact being that only 45 per cent. are now occupied, the commission having designed to build for future needs.

Mr. Cushing: My experience has been in Chicago, where the underground question was first discussed in its entirety, and where the electric lighting companies are all underground. We have all kinds of conduits there. I think a simple wooden pump log has been found equal to, or better than, most of the more expensive conduits. The ideal conduit, of course, is a subway in its true sense. I think the Chicago Telephone Company has built one or two blocks of such a subway, seven feet high and four feet wide, with the cables at the side and incandescent lamps hung through the tunnel. The World's Fair will also have a subway plan for the distribution of their main wires. It will be a large affair—eight feet high and four feet wide.

On motion of Mr. Seeley, the meeting adjourned until 3.30 P. M.

Afternoon Session.

The President called the meeting to order at 3:45 o'clock.

Mr. Armstrong offered the following resolution:

Resolved, That the members of the National Electric Light Association extend their hearty thanks to the Bell Telephone Company, of Buffalo, and the American Telephone and Telegraph Company, of New York, and the Postal Telegraph and Cable Company, for their very great kindness and courtesy in extending to us the free use of their wires; privileges of which we have shown our appreciation by a very general use, and which have helped greatly to the enjoyment of our very pleasant stay in the City of Buffalo. To our President, and the citizens of Buffalo, who have so hospitably treated us, we desire to extend our hearty thanks. We close this Convention with the firm conviction that it has been the most successful one in our history.

The resolution was adopted amid applause.

The Association then went into executive session.

The following officers were elected for the ensuing year:

President, James I. Ayer, St. Louis, Mo.
First Vice-President, E. A. Armstrong, Camden, N. J. Second Vice-President, C. H. Wilmerding, Chicago, Ill.
Secretary, George F. Porter, New York.

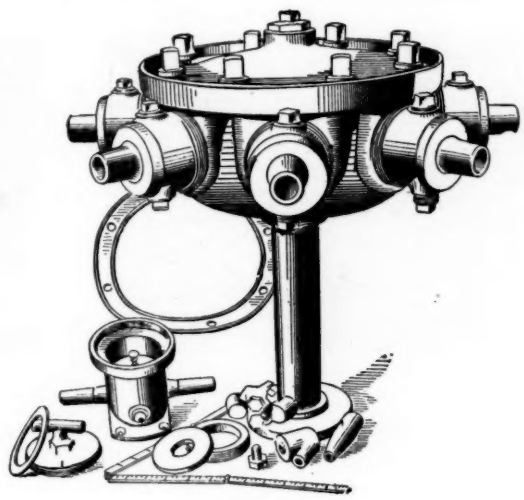


FIG. 3.

Executive Committee, three new members, H. H. Fairbanks, Robert Mackie, C. Lee Abell. Members holding over, John A. Seeley, E. F. Peck, Chas. R. Faben, Jr., Frederic Nicholls, M. D. Law, A. M. Young.

The next meeting of the Association will be held in St. Louis, Mo., February, 1893.

THE ATTENDANCE.

LADIES.

Mrs. Schuyler S. Wheeler, New York.
Mrs. W. J. Johnston, New York.
Mrs. C. O. Baker, Jr., Newark, N. J.
Mrs. M. J. Francisco, Rutland, Vt.
Mrs. N. V. Titus, Boston.
Mrs. Frank Ridlon, Boston.
Mrs. E. L. Ross, Indian Orchard, Mass.
Mrs. S. S. Sherman, Boston.
Mrs. James Ferguson, Brooklyn.

Chicago, Ill.—Wm. S. Armour, John I. Beggs, A. H. Bauer, George Cutter, Frank B. Platt, T. J. Lovett, W. W. Low, C. H. Wilmerding, Edward Ellicott.
Boston, Mass.—C. E. Bibber, Capt. Wm. Brophy, H. S. Chase, L. S. Dumoulin, Paul G. Fiedler, C. S. Haley, F. T. G. Hill, Welles E. Holmes, P. H. Hover, C. W. Houghton, J. H. Mason, Louis McCarthy, F. S. Pearson, Frank Ridlon, E. L. Ross, Geo R. Stetson, J. B. Smith, S. S. Sherman, N. V. Titus, D. T. Urquhart, W. F. Walker, C. A. White.
Bristol, R. I.—F. S. Minott.
Buffalo, N. Y.—Frank W. Abbott, G. A. Bennett, A. A. Berrick, P. P. Beals, F. P. Little, Dr. W. H. Heath, F. C. Hoddick, C. R. Huntley, W. C. Jaynes, A. W. Lockwood, A. B. Penfield, P. K. Stern, Geo. J. Urban, A. C. Terry, David Tucker, W. T. Wilson, C. L. Abell. John J. Sly and A. B. Weaver, Association Stenographers.
Akron, O.—F. H. Bostwick, C. J. Butler.
Baltimore, Md.—E. E. Ries, W. S. Horry.
Bradford, Pa.—J. H. Rose.
Bridgeport, Conn.—W. C. Bryant, J. M. Orford.
Camden, N. J.—Hon. E. A. Armstrong.
Brooklyn, N. Y.—W. S. Barstow, Jas. Ferguson, C. J. Foyl, E. F. Peck. T. E. Crossman, Stenographer.
Canandaigua, N. Y.—C. J. Purdy.
Cincinnati, O.—Chas. E. Jones, Luke Lilley, Robb Mackie.
Cleveland, O.—S. S. Leonard, I. R. Prentiss, Fred. Schiffler.
Cuyahoga Falls, O.—E. L. Babcock.
Danbury, Conn.—E. T. Wightman.
Detroit, Mich.—O. D. Chase, Geo. E. Fisher, B. P. Van Court.
Erie, Pa.—M. N. Lovell, A. L. Daniels.
Fitchburg, Mass.—H. F. Coggshall.
Hartford, Conn.—Chas. J. Hills, E. B. Hatch, C. E. Newton, C. L. Tolles, A. H. Pease.
Houghton, Mich.—Jas. R. Dee.
Herkimer, N. Y.—John Kelley.
Indiana, Pa.—S. M. Wheeler.
Indian Orchard, Mass.—E. Ross.
Jersey City, N. J.—Chas. A. Learned.
Lancaster, N. Y.—W. F. Holloway.
Lynn, Mass.—Elihu Thomson, Caryl D. Haskins.

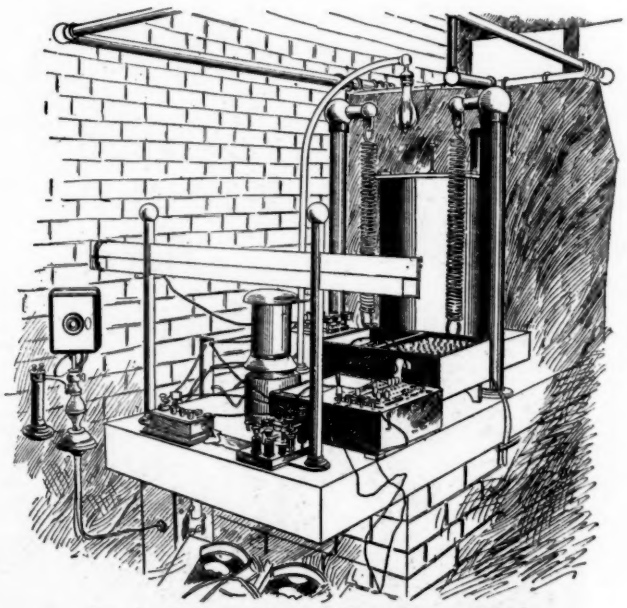


FIG. 4.—TESTING ROOM FOR UNDERGROUND WORK.

Mrs. T. J. Smith, New York.
Mrs. M. D. Law, Schenectady, N. Y.
Mrs. E. A. Willyoung, Philadelphia.
Mrs. G. A. Redman, Rochester.
Miss A. E. Redman, Rochester.

GENTLEMEN.

New York City.—P. C. Ackerman, E. P. Atkinson, P. H. Alexander, W. M. Andres, E. E. Bartlett, S. S. Bogart, W. H. Browne, Capt. W. L. Candee, R. B. Corey, W. F. Cullen, F. S. DeRonde, F. Darlington, Jarvis B. Edson, J. W. Godfrey, S. R. Hunt, A. E. Hall, R. S. Hare, H. G. Issertel, A. A. Knudson, A. B. Laurence, H. Ward Leonard, E. A. Leslie, C. P. Mackie, D. B. McCoy, W. R. McLaughlin, George T. Manson, Augustus Noll, H. B. Oakman, E. H. Peck, George F. Porter, J. C. Pierrez, Isaac M. Post, M. C. Roach, S. Rosenstamm, C. A. Schieren, C. A. Schieren, Jr., John A. Seely, T. J. Smith, M. C. Sullivan, F. H. Sparling, Robert J. Sheehy, Charles D. Shain, E. W. Seymour, P. H. Van der Weyde, S. S. Wheeler, Erastus Wiman, W. H. Wood, Benjamin R. Western, H. C. Whitney, G. L. Wiley, A. S. Brown, Master Edwin Christie Johnston.
Dayton, O.—W. H. Ashton.
Minneapolis, Minn.—A. M. Robertson.
Montreal, Can.—A. J. Corriveau.
Morristown, N. J.—F. J. Anderson.
Newark, N. J.—C. O. Baker, Jr., R. D. Heinrich, C. H. McIntire.
New Bedford, Mass.—Chas. R. Price.
New Britain, Conn.—L. C. Whitney.
New Brunswick, N. J.—A. J. Jones.
Niagara Falls, N. Y.—C. M. Morse, F. E. Pritchard.
North East, Pa.—J. R. Phillips, N. S. Possons.
Ogdensburg, N. Y.—J. H. Findlay.
Owen Sound, Ore.—Jno. Parker.
Ottawa, Can.—W. F. Soper.
Philadelphia, Pa.—A. E. Braddell, C. H. Clay, H. A. Cleverly, H. B. Cutter, A. J. DeCamp, C. M. McIntire, J. K. Martin, A. H. Mainwaring, H. T. Paiste, W. N. Famous, G. W. Vallee, E. S. Willyoung, E. W. Wilkins, Wm. H. Weston.
Pittsburgh, Pa.—Dan. Ashworth, Maurice Coster, G. T. Evans, Morris W. Mead, H. Robbins, L. B. Stillwell, Townley Calvert.
Pittsfield, Mass.—Chas. Atwater, R. Fessenden, Henry Hine, John W. Noble, Wm. Stanley, Jr., W. A. Whittlesey, C. C. Chasney.
Poughkeepsie, N. Y.—J. N. Candee, Jas. B. Platt.
Port Huron, Mich.—J. W. Smith, D. J. Stephenson.
Providence, R. I.—Marsden J. Perry.
Pueblo, Cal.—E. M. Reed.
Ravenna, O.—Chas. L. Rodman.
Reading, Pa.—J. L. Boyer.
Rockford, Ill.—W. B. Roberts.
Rochester, N. Y.—J. G. Kaelber, Edgar A. Gay, C. B. Griffith, J. E. Putnam, G. A. Redman.
Rutland, Vt.—M. J. Francisco, Master Don Francisco.
Schenectady, N. Y.—M. D. Law, F. A. Stevenson.
Seneca Falls, N. Y.—R. H. Aldrich, R. H. A. Heastley.
Sewickley, Pa.—E. P. Young.
Springfield, Ill.—A. L. Ide.
St. Louis, Mo.—James I. Ayer, J. H. Rhotehamel, E. Reubel.
Salem, O.—D. L. Davis.
Stubensville, O.—J. Gwynn.
Syracuse, N. Y.—Thomas H. Fearey, E. P. Doen, J. D. McIntyre, James Pass, S. H. Riker, A. P. Seymour.
Telluride, Colo.—P. N. Nunn.
Toronto, Can.—Frederic Nicholls, W. J. Morrison, H. D. Thornberry, H. S. Thornberry, Master Harry Nicholls.
Trenton, N. J.—J. T. Ridgeway, Richard K. Whitehead.
Waterbury, Conn.—D. L. Hungerford.
Utica, N. Y.—W. F. Bossart, M. G. Brayton.
Warren, O.—W. D. Packard.
Washington, D. C.—Allen R. Foote, Fred. W Royce, J. N. James.
Washington C. H., O.—Jerome Penn.
Worcester, Mass.—M. H. Fairbanks.
Windsor, Conn.—M. E. Baird, A. D. Newton.
Wilmington, Del.—Frank D. Sweeten, C. R. Van Trump.

The electrical newspapers were represented as follows:

ELECTRICAL REVIEW.—Charles W. Price, Stephen L. Coles, H. T. Richards, M. J. Bulkley.
Electrical Engineer.—George M. Phelps, T. C. Martin, Joseph Wetzler, F. R. Colvin, A. C. Shaw, W. F. Collins, L. W. Collins.
Electrical World.—W. J. Johnston, Dr. Louis Bell, Carl Hering, Edward Caldwell, L. H. Hart, J. Stanford Brown.
Western Electrician.—W. A. Kreidler, J. B. O'Hara, W. F. Osborne.
Electrical Age.—W. T. Hunt, J. B. Taltavall, T. R. Taltavall, N. D. Webster.
Electrical Industries.—E. L. Powers, E. E. Wood.
Electricity.—W. H. Temple.
Electric Power.—R. W. Pope, A. E. Davis.
Street Railway Journal.—E. N. Dickerson.
Power-Steam.—H. M. Swetland.
Street Railway Gazette.—M. J. Sullivan.

Entertainment of the International Okonite Company, Limited.

A very entertaining departure was made by the International Okonite Company, Limited, the well-known manufacturers of insulated wires and cables, of New York City and London. The Messrs. Willard L. Candee and George T. Manson were in attendance, accompanied by Marshall P. Wilder, the well known humorist, and every evening during the Convention their parlors were filled with electrical people, who greatly appreciated this opportunity to lay aside scientific and practical work to enjoy the delightful recitations, sketches, etc., by Mr. Wilder, and the piano playing of his assistant, Mr. Kendall. In addition a late supper with superb punch was served to the visitors at the Okonite headquarters, and a special brand of Okonite cigars—and a very excellent brand they are—were given out by the hospitable representatives of this company. The ladies who accompanied the delegates to the Convention were also invited to these pleasant gatherings, and they, as well as the gentlemen, were very hearty in the praise awarded to this company and its representatives for the many pleasant moments passed at the Okonite headquarters. Mr. Wilder never appeared to better advantage than when speaking before the intelligent faces of the electrical gentlemen and ladies, and was particularly happy in the application of his sketches. The attendance at these little parties made a very representative gathering of electrical men, beginning with Professors Thomson, Gray and Van der Weyde, down to the newest comer in electrical work, and the Messrs. Candee and Manson were voted the best of friends to the hard working electrical fraternity in thus giving them the pleasure of listening to one of the most enjoyable entertainers of the country and passing several delightful hours together socially.

Young Men's Institute.

A course of scientific lectures has been arranged by the Carriage Builders' National Association, to be given at the Technical School for Carriage Draughtsmen and Mechanics, Young Men's Institute Hall, 223 Bowery, New York, commencing on Wednesday, February 17. These lectures are free to any young men applying for tickets, and are upon subjects of much interest by well-known authorities, such as Professor Morton, Professor Denton, Professor Webb and Chas. B. Dudley.

"From the Tannery to the Dynamo."

BY CHAS. A. SCHIEREN, BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, AT BUFFALO.

It may be of interest to engineers, and the electric light fraternity in general, to learn something of how leather is tanned, and the various processes through which a hide passes before it is tanned and curried ready to be put into belting. Naturally, the first question will be, "Where do all the steer hides come from?" Principally from Chicago, because within its city limits there are four large slaughtering establishments where thousands of cattle are slaughtered daily, the hides of which are carefully taken off and assorted for whatever purpose they are best suited. The hides which are heaviest and most perfect in point of freedom from cuts, brands and other blemishes, are selected for belting leather. These hides are put up in bundles, packed into a freight car, and shipped to the tannery.

We propose to follow one of these freight cars loaded with belting hides to its destination. After a journey of about 600 miles, the car arrives at the little station of Adamsburg, Pa., right in the mountain region, a spur of the Alleghenies, where the tannery is situated.

Oak tanneries are generally placed near the bark region of the mountains, where the rock oak tree predominates, the bark of which is universally conceded to be the best for making the finest grade of leather.

Our car of belting hides has arrived at the station, and we will watch the process of tanning. The hides are examined and weighed, and put into the shed; an equal number of hides are taken out daily (whatever the capacity of the tannery may be) and placed in a large vat of pure cold water, generally good spring water. After the hides are thoroughly soaked and the dirt washed out, they are laid across a beam and, with a blunt fleshing knife, the surplus fat or meat still remaining is taken off; then they are placed in a vat of weak lime-water, and are hauled up daily and the lime strengthened until the hair gets loose, which action takes about eight days. After this the hides are cleansed once more in pure water and placed over the beam and, with a blunt knife, the hair is removed; this part of the work is done in what the tanners call the beam or lime house, and very much depends upon the successful liming process in making good leather.

After the hair is off, the hides are washed again and thoroughly cleansed and purified, to remove every particle of lime, after which process they are taken into the handlers. These are composed of large vats, about seven by nine feet, and six feet deep. The hides here are laid across sticks side by side, as close as possible, and hung about three inches below the top of the vat. These vats are generally connected so that when the first vat is fed the tannin liquor will pass through every vat until they are all filled, and cover the hides completely. In the handlers the hides receive their first bath of tannin liquor, which is very weak at the start, and gradually strengthened. During this first stage of tanning the hide plumps up, and is prepared for the lay-aways; this process also opens the pores and swells the hide, which gives thickness and firmness to the leather. If the hides cannot be made thicker at this period of the tanning, they will never be made heavier afterward; this is the critical point and has to be watched closely; much depends upon the character of the tannic acid; if too strong, it tends to make the leather brittle and harsh; if the tannic acid should be too sour, it tends to make the leather soft and flabby.

Some tanners use a rocking process to keep the hides in motion, thereby opening the pores of the hide quicker to receive the tannic acid; however, opinion differs as to the utility of the rockers, some claim (and justly) that the rocking motion loosens the fibre of the hide, and softens the leather too much. The best process is to simply hang them in the vats and cover them with the tannin liquor, and raise them a few times during the day, or draw the liquor through them, which some tanners are now doing with success. The tannic acid in the handlers generally has a strength of from five to 15, very seldom over 20, degrees. The hides remain in that process from 10 to 12 days, they are then taken up and, if they are to be used for belt leather, the flanks (bellies) and heads of the hides are cut off and tanned separately; the remaining butt part receives an extra layer of bark to tan it more thoroughly and make it firmer.

From the handlers the hides are packed away in vats, called lay-aways; these are large vats seven by nine feet, and six feet deep, having a capacity of from 50 to 75 hides each. The vats are not connected with each other, but only with the pump to change the liquor. The hides are laid nicely one on top of another, and loose ground bark spread between each hide, and when the vat is full it is filled with tannin liquor of from 25 to 30 degrees in strength. The hides intended for belting receive at least six layers of bark, or in other words, are changed six times in the lay-aways; the first time they are changed after lying ten days, and then five days are added after each layer, so that the hides in the last or sixth layer will take forty days to absorb the tannin liquor and penetrate the leather. Each time fresh ground bark is spread between the hides and then covered with tannin liquor.

The leaching and grinding of the bark is an important factor in a tannery. The large pieces of bark taken from the oak tree are thrown into a hopper-shaped mill or grinder, which resembles a coffee grinder on a large scale. The ross on the outside of the bark creates a great deal of dust, and contains little or no tannin, but it cannot be severed from the rind which really contains the acid; from the bark mill the ground bark is elevated into large tubs which have false bottoms, or receivers underneath to take up the tannin liquor. After a tub is filled with ground bark, a rotary sprinkler is set in motion to saturate the bark with a spray of water or liquor, which percolates through the ground bark, and on its way to the bottom catches up the tannic acid contained in the bark; at times warm water is used to facilitate the operation, also weak tannin liquor is used sometimes with good effect; however, old school tanners prefer cold water, which they claim makes purer and sweeter tannin liquor. After the receivers at the bottom of these tanks are filled, the contents are pumped into large supply tanks, from which the liquor is distributed through the tannery as required.

The leaching process is the most interesting and valuable operation in the tannery, and upon its skillful management depends the financial success of the business; opinion differs very materially as to the best method. The large round leach tubs, such as described, are the most popular now in use; however, many tanners still adhere (and some with success) to the old square pressed leach tubs, in which the ground bark is simply soaked or steeped in water and left for a length of time, until the tannic acid is extracted from the bark. Opinion also differs as to using steam or hot water; however, all have their merits.

Very strange and erroneous ideas prevail among those who use leather, and have no knowledge of the art of tanning; certainly it is an art, and one of the oldest handed down to us. The general opinion prevails that leather made in "ye olden time" is superior to ours of the present time, but such is not the case; in fact, the fundamental process of tanning to-day is precisely the same as that of a thousand years ago, except that we enjoy improved machinery and appliances which further the process and improve the material.

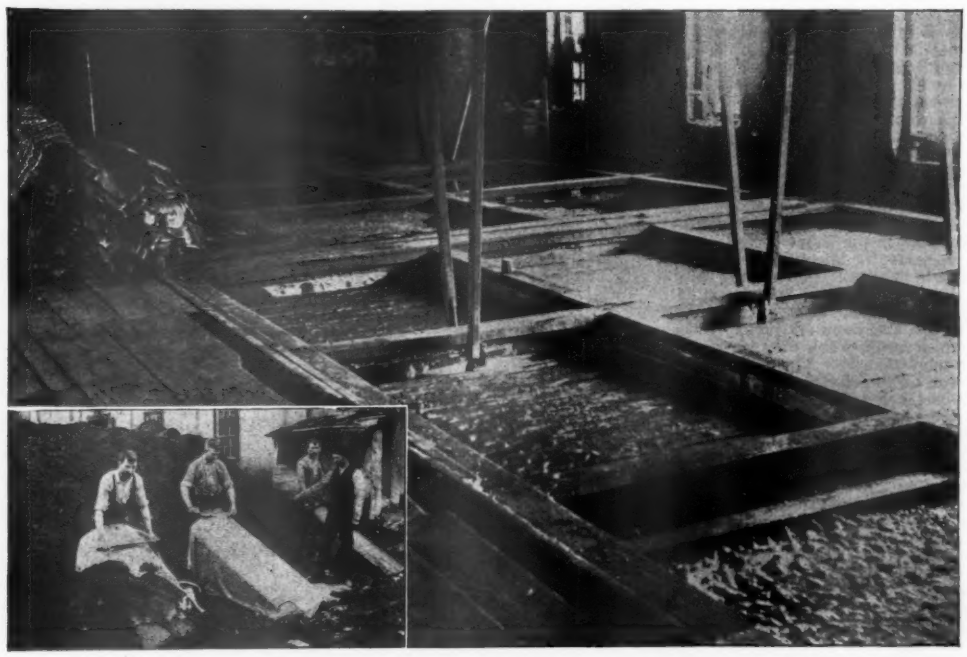
FIGS. 1 AND 2.—See "FROM THE TANNERY TO THE DYNAMO."

When the leather is taken from the last layer of bark, it is oiled on the grain and hung up in a darkened room to dry; to obtain a nice clear russet color the place must be kept at an even temperature, and very little heat used. After the leather is thoroughly dried it is put up in rolls containing five butts (hides) each, and whenever a carload is ready it is shipped to New York; here it is again examined and weighed, and all butts not suited for belting are thrown out and finished into sole leather for shoe purposes.

The perfect hides for belting are soaked in warm water, and the center part cut out and used for prime belting; the waste or offal is finished and rolled for shoe purposes. When the pieces are thoroughly scoured and cleansed they are oiled on the grain and hung up to dry, and when in a semi-dry condition, they receive a coat of stuffing made of equal parts of cod oil and beef tallow. This is done to preserve the leather and make it pliable for the transmission of power. After the stuffing has entered the pores, which takes about 24 hours, the leather is subjected to great strain in large stretching machines; great care and good judgment must be manifested in this part of the process, each piece of leather must receive an equalizing strain because of the peculiar formation of the hide, the fibres being very fine and closely knit together on the back of the animal, and running coarser and thicker towards the flanks. It is of the highest importance, for belts intended for electric light plants, to have an equal tension over the entire surface of the belt; therefore, the stretching process of belt leather needs the utmost care, and should receive the closest attention. After the pieces of leather are thoroughly stretched, they are worked smooth on the grain side, and both by hand and machine labor are set down as solid and compact as possible; then they are put into a drying room and thoroughly dried. Afterwards one edge of the pieces is straightened, and they are then cut into whatever width of belt they are best suited for; the pieces of each width are matched accurately as to thickness, and then the laps (joints) are cut by a machine, the edge of the laps are feathered, and the joints cemented (glued) together, and pressed under a hydraulic press, which pressure is considered the best by all first-class belt makers.

Rivets are now rarely put into belts; a double belt well cemented is good for all ordinary purposes, and rivets are superfluous; however, certain fastenings, such as endless copper wire screws, which do not obstruct the surface or unnecessarily stiffen the belt, are a benefit; especially when the belt comes in contact with water or too much oil, this fastening prevents the belt from coming apart, and holds the leather firmly together.

All main driving belts over 40 inches in width have to be made in sections, consisting of two or more pieces of leather cemented together; the average hide for belting does not contain more than 40 inches in width of solid leather suited for belting; very rarely over that; therefore, wide main belts are made in sections. Ordinarily the pieces are not lapped parallel, but simply butted. For example: A 60 inch double belt receives two 30 inch pieces for the first layer, laid side by side, and a 30 inch piece over the center of the two lower pieces to break the joint,



FIGS. 3 AND 4.—See "FROM THE TANNERY TO THE DYNAMO."

and two 15 inch pieces on top of each edge of the lower layer to complete the width; thus the belt is cemented together. However, for electric light plants where belts are run at high speed and with variable power (which produces sudden strain), the seam of these butted joint belts, in several instances, broke, doubled up and destroyed the belts completely. To guard against such a calamity it is considered advisable to make wide main driving belts with parallel joints. For example: A 60 inch double belt will be made of two 33 inch pieces joined parallel, with a three inch lap, making one solid piece 60 inches in width, and on the upper part put a 33 inch piece in the center, and two 18 inch pieces on the

edges, all joined with parallel laps; this cemented together will make a 60 inch double belt with unbroken surface, and as one solid piece of leather having a uniform tension and able to withstand an equal strain over the belt transversely as well as parallel, and thus will prevent such large, heavy driving belts from collapsing at the parallel joints. Every one must admit that main belts made on this plan are superior, and more reliable, and would come into general use if it were not for the additional cost of labor and material in making them.

Leather being by nature an absorber of moisture, belts must be guarded against exposure to oil. In electric light and power plants much mineral oil is used, and the great velocity at which the belts are run seems almost imperceptibly to suck or draw the oil from the journals of the engines and dynamos, and allow it to be absorbed by the belts, which get completely saturated with oil, and in a short time rot and destroy the fibre of the leather. Various methods have been used to overcome this difficulty. One of the most successful is a certain composition or belt dressing which is rubbed over the surface of the belt, and closes the pores of the leather. No foreign substance can penetrate a belt treated with this compound, and the belts last much longer and give better service. With perforated belts this compound does not seem to be so effectual, because the perforations naturally expose the inner part or the heart of the leather, which is very porous; however, the surface of the belt being covered it shields that part of the leather which comes in contact with the pulleys, and the current of air passing through the perforations protects the belt to a certain extent, and that class of belt runs smoother, with less friction and is more reliable.

And now, gentlemen, we have reached the point where another curious and erroneous idea prevails among many engineers, namely, that belting should be made of pieces only four feet in length; as if all hides were of the same length and texture; it will surprise these men to learn that there are no two hides alike, they vary in some particular point. Hides exist which will make almost six feet of sound solid leather below the shoulder, and again some hides will not make four feet of solid length; the only safeguard is to specify belting made of leather cut below the shoulder of the hide, irrespective of length.

The Transmission of Electric Energy by Alternating Currents and its Utilization by Continuous Currents.

BY H. WARD LEONARD, BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

For more than ten years we have had at our command the means, through the agency of the continuous current, of transmitting electric energy in unlimited quantities over short distances and converting it into mechanical power for any desired application.

The hundreds of three-wire systems illustrate this statement.

For more than five years we have had at our command, through the agency of the alternating current, the means of transmitting electric energy in unlimited quantities over almost any desired distance; but we have not had the means of converting such energy into mechanical power for commercial uses, for there is but little commercial use for a motor which is not self-starting and which, when started, can be operated at but one speed. Hence, the commercial use of the alternating current has thus far been confined to the operation of incandescent lamps.

During these past years the companies promoting the sale and use of continuous current apparatus have been making plans and estimates of continuous current transmissions, using several thousands of volts directly from commutator to commutator; but neither they nor the public have had the necessary confidence in the result to install the plants. The developing and perfecting of a continuous current, constant potential generator of 1,200 volts, has forcibly impressed at least one company with the difficulties likely to be met with in constructing similar apparatus of 600 volts and upwards.

At the same time the various companies promoting the sale and use of alternating current apparatus have devoted all their efforts to the devetopment of an alternating current motor which should possess the essential qualities of variable torque and variable speed under variable work.

Thus far, neither line of development has resulted in the production of commercial apparatus for the transmission of power over great distances.

I stand here to make the claim that the transmission of power over great distances necessitates the use of both the alternating and continuous currents, and that by the combined use of the systems the result is commercial to-day over any reasonable distance and for the transmission of any amount of power.

I arrive at this conclusion as follows:

The economical use of electric energy with automatic control of the speed and torgue, demands that the voltage be varied as the speed and the current as the torque.

It will be evident that for merely transmitting electric energy from a prime motive power of constant speed there can be nothing simpler or better than the synchronous alternating current motor of constant potential. But nearly every application of the transmitted power demands not only a variable torgue but a variable speed, as will be evident when we consider hoists, locomotives, pumps, ventilating fans. The synchronous character of the alternating current is, therefore, unsuited for such work. We should have means of varying the voltage in proportion to the speed desired, and means of varrying the current in proportion to the torque of the power to be supplied. We should also have a current adapted to charge storage batteries and to deposit metals electrolytically. All those conditions point directly and conclusively to the continuous current.

It would seem, therefore, that both theoretical and practical considerations demand that we should transmit our energy over the great distances demanded for commercial applications by means of the alternating current, and that we should then convert our electric energy into a continuous current in order to best utilize it in the actual performance of the work met with in practice.

Let us suppose, for example, that we have a water power at a distance of 20 miles from a mine where it is desired to utilize 2,000 horse-power for various purposes.

Let us start with 10,000 volts and lose 22 per cent. in the conductor. The cost of our generator conductor and synchronous motor will be about $90 per horse-power at the point of work. The synchronous motor will drive the necessary continuous current generators of 500 volts and less to supply hoists, pumps, locomotives, ventilating fans, air compressors, incandescent lights, arc lights, crushers, mills, etc.

If the total power installed be 2,000 horse-power, the cost of the working motors will be perhaps $50,000. With 2,000 horse-power installed the maximum demand for power will not exceed 1,500 horse-power. The cost of continuous current generators and conductors for this service will be about $52,500, and the cost of the synchronous transmission system about $135,000.

Allowing $42,500 as an average cost for the development of the water-power and the construction, we have total cost of plant of $280,000 or $140 per horse-power represented in the electric motors at the point of work.

With such simple, efficient and cheap apparatus made by many companies to-day, why should we wait for the solution of such difficult problems as commutators to stand 10,000 volts or alternating current motors which will be self-starting and efficient, and at any speed and torque.

Even if we had such motors, it is evident that we must interpose some kind of convertors to reduce the 10,000 volts to a reasonable pressure for applications in mines, and we would still require continuous currents for commercial arc lamps, storage batteries, electro-deposition, etc., and a special current for electric drills.

If one comprehensive plant be installed of this alternating and continuous current type, I believe an enormous development in this line will immediately follow, and luckily the apparatus required can be turned out rapidly from any one of several large works without the delays incidental to the development of new apparatus and methods.

Electrical Newspaper Litigation.

A judgment was entered in the Supreme Court, February 18, in the case of the W. J. Johnston Company, Limited, the publishers of *The Electrical World*, against Walter T. Hunt and the *Electric Age* Publishing Company. In June, 1890, Hunt agreed to work exclusively for the Johnston Company for a term of five years, at a salary of $4,000 a year. The Johnston Company asserted that about the first of January, 1891, Mr. Hunt demanded the sum of $10,000 in cash and threatened that unless his demand was complied with he would leave the plaintiff's employ, taking "half of its business away with him." The company did not comply with Mr. Hunt's demands, according to the story told by its president on the witness stand, and Mr. Hunt left the employ of the plaintiff and entered that of the defendant, the *Electric Age* Publishing Company. Judge Ingraham, before whom the suit was tried, decided that the facts as maintained by the plaintiff were correct and gave judgment in favor of the plaintiff, restraining Hunt from working for the *Electric Age* Publishing Company during the period for which he had agreed to work for that company, that is, to the first of June, 1895, and also enjoining that company from employing him at any time during the same period.

GENERAL NOTES OF THE CONVENTION.

The trip to the Niagara tunnel on Wednesday was enjoyed by all who went. A full description of the work was given in the Decennial Number of this journal.

No general exhibit was given, but many houses placed on view certain specialties of their manufacture.

A. S. Brown, of the Security Insulator Company, of New York, was there with samples of their new insulators.

The Edison General Electric Company gave an exhibition of their wares at their salesrooms in Buffalo.

Hart & Hageman, of Hartford, Conn., was represented by A. H. Pease, secretary and treasurer, who showed a full line of their goods.

J. W. Godfrey and Augustus Noll shed light upon the "Grimshaw" wire and Vulca ducts.

The Eureka Tempered Copper Company, of North East, Pa., were represented by N. S. Possons, who displayed a fine line of their specialties.

The Bryant Electric Company, of Bridgeport, Conn., was there with samples of their sockets, switches, etc. W. C. Bryant was present.

C. E. Newton and Charles Tolles exhibited samples of Jewell belting.

The Dayton Fan and Motor Company, represented by W. H. Ashton, distributed a handsome memorandum.

The Partrick & Carter Company, of Philadelphia, were represented by E. Ward Wilkins.

W. D. Bossart, of the Utica Electric Manufacturing and Supply Company, showed a sample board of their specialties.

A fine line of the Crocker-Wheeler motors was shown by F. W. Little & Company, Buffalo agents.

A. B. Laurence exhibited samples of the Shultz belting.

The Eddy Motor Company were represented by Mr. A. D. Newton and Mr. M. E. Baird—two of the handsomest men in attendance.

W. W. Law showed samples of the Electric Appliance Company, of Chicago.

One of the Otis Brothers & Company's new electric pumps was exhibited by Mr. A. E. Hall.

The Beacon Vacuum Pump and Electric Company, of Boston, made an exhibit of its lamps. The company was represented by S. S. Sherman.

The Phœnix Glass Company was there in the genial person of E. E. Peck.

Pass & Seymour showed some fine porcelain novelties.

General Manager S. V. Doty, of the Aluminum Carbon Company, was one of the Buffalo reception committee.

Gould & Watson's interests were well looked after by E. P. Sharp.

C. G. Butler showed some fine samples of the Paranite Rubber & Insulated Wire Company, of Jonesboro, Ind., consisting of sections of aerial and submarine wires, tapes, tubing, etc.

Jas. J. Murray & Company, of Philadelphia, displayed their line of glass globes; J. K. Martin was in charge.

Elias E. Ries, President of the Ries Electric Specialty Company, of Baltimore, ably looked after its interests, showing its regulating socket for incandescent lamps.

The Electric Secret Service Company had a fine example of their lamp cut-out in operation in charge of General Manager C. P. MacKie and Electrican S. S. Bogart.

The Lovell Manufacturing Company, of Erie, Pa., was well represented by M. N. Lovell.

The E. P. Gleason Manufacturing Company showed a line of their electric globes, shades, fixtures, etc., in charge of W. F. Cullen.

General Manager W. A. Fenn, ably represented the American Electric Supply Company, of Buffalo.

Frank De Ronde and H. B. Cutter were on hand for the Standard Paint Company.

Robb MacKie, for the past two years electrical engineer of the Allied Electric Light Companies, of Cincinnati, has resigned that position to establish an office as consulting engineer in that city. Mr. MacKie was formerly general superintendent of the Fort Wayne Electric Company, and is widely and favorably known to the profession, having been elected a member of the executive committee of the National Electric Light Association at the recent Buffalo meeting. His long and varied experience in practical electrics fits him peculiarly for the occupation he has adopted, in which we wish him every success.

H. B. Cutter sohwed the new flexible tubing of the Cutter Electrical and Manufacturing Company, of Philadelphia.

The Electric Construction and Supply Company, of New York, was well represented by its genial manager, R. B. Corey.

The handsome Paiste china switch was displayed by H. T. Paiste.

The Edson pressure gauge was exhibited by Jarvis B. Edson. Some beautiful specimens were shown.

The Consolidated Electric Manufacturing Company exhibited the Hamil arc lamp. C. E. Bibber was in charge.

J. M. Orford, of the Union Electric Manufacturing Company, of Bridgeport. was on hand looking after the interests of his company.

W. H. Weston & Company, of Philadelphia, showed their quick acting switches.

The Eco Magneto Watchman's Clock was explained by Mr. White, president of the company.

The Columbia Lamp Company, of St. Louis, was well represented by J. H. Rhotehamel.

Prof. Richard O. Heinrich ably represented the Weston Electrical Instrument Company, of Newark, N. J.

The interests of the Chapman Valve Manufacturing Company, of Indian Orchard, Mass., were looked after by Edward T. Ross.

P. C. Ackerman was on hand with samples of the goods of the American Electrical Works, of Providence.

C. S. Van Nuis was present looking after the interests of the specialities of his manufacture. He presented his friends with neat miniature Ajax switches to be used as paper weights.

"Uncle Dan" Hungerford was present for Benedict & Burnham, of Waterbury, Conn. Mr. Hungerford occupied a handsome parlor on the first floor where several reels of his company's wire were on exhibition. Mr. Hungerford presented each of his friends with a neat sample case containing several sizes of Benedict & Burnham's weather-proof wire which has recently withstood some very severe tests.

The Buffalo Banquet.

The members of the National Electric Light Association, during their stay in Buffalo, were the recipients of a handsome colation, at the hands of the citizens of that place. The banquet was given in the board room of the Merchants' Exchange, was attended by some 400 persons and proved a brilliant affair.

In the seat of honor was Mayor Bishop. At his right was Mr. Huntley, the retiring president; at his left was Mr. James I. Ayer, of St. Louis, the new president. Next to Mr. Huntley was Prof. Elihu Thomson, of Boston. Prof. Elisha Gray, of Chicago, John N. Scatcherd of Buffalo, famous Marshall P. Wilder, Capt. W. L. Candee, C. O. Baker, Jr., Geo. F. Porter, and all those on the toast list, also had seats at the head of the table.

On the reception committee were Messrs. George Urban, Jr., C. Lee Abell, Thomas Hogdson, W. W. Sloan, Daniel O'Day, S. F. Eagan, J. M. Brinker, P. P. Miller, F. P. Little, W. A. Fenn, F. V. Doty, H. B. Oakman, H. M. Gerrans, Thomas Cary, B. L. Sheldon, James Adams, J. A. Roberts, E. Michael, L. B. Crocker, R. K. Noye, F. A. Bell, A. A. Berrick, James Bolland, Arthur D. Bissell, A. R. James, F. W. Hayden, Joseph P. Dudley, F. D. Locke, C. A. Sweet, J. L. Williams, W. G. Case, J. N. Scatcherd, C. M. Morse, F. P. Jones, W. C. Newman, George H. Lewis, Walter T. Wilson and R. J. Getz.

After justice had been done to the full-course dinner, Mr. Huntley arose, rapped for order and in a few well-chosen words introduced Mr. John N. Scatcherd as toastmaster. Mr. Scatcherd performed the duties of his difficult position with grace and wit. He bid the guests a hearty welcome and pleasantly introduced Mayor Bishop to speak in reply to the toast of "The City of Buffalo."

The Mayor spoke eloquently upon this subject, and then followed the toast, "The National Electric Light Association," responded to by Judge Armstrong. Richard K. Noye, of Buffalo, spoke to "Buffalo Manufacturers;" C. H. Wilmerding, to "Municipal lighting;" John G. Milburn, to "Buffalo Electricity;" T. Commerford Martin, of the *Electrical Engineer*, to "The Electrical Press;" Chas. F. Kingsley, to "The Buffalo Press," and Prof. Elihu Thomson, to "Electricity." Mr. Ayer, the new president, was called upon and made a few pleasant remarks.

The toast of "Our Partners in Niagara Falls," in the absence of Prof. H. A. Bovey, of Canada, was responded to by Mr. A. J. Corriveau. The whole affair passed off most pleasantly, and will doubtless be long remembered by those present.

KINDRED INTERESTS

The Direct United States Cable Company, Limited, and the Eastern Telegraph Company, Limited, have forwarded us a handsome paper cutter on which are given a calendar for 1892, and sections of the map showing the location of the cable lines of these great corporations. It is quite unique and convenient.

The New England Butt Company, of Providence, R. I., have just received a diploma and medal for the best exhibit of braiding and winding machinery at the Augusta Exposition, Augusta, Ga., and are to be congratulated. This firm is always to be found in the front rank, due to their good business methods, push and the superior quality of their wares. Their drilled cast butt hinges, hardware specialties and braiding machinery are not the only articles furnished, for they are well equipped to supply iron castings, patterns, etc., and having a machine shop in full operation, are prepared to contract for machinery and other specialties. Their annealing furnaces enable them to anneal both iron and steel. Write to them.

Good Work of the Heisler Company.

The plant erected by the Heisler Electric Company for the corporation of West Toronto Junction, Ontario, Canada, has been inspected and formally accepted by the town authorities. Mr. J. J. Wright speaks in the following terms of the installation, which certainly is an excellent endorsement of the work done by the Heisler Company:

"I have examined the plant installed by the Heisler Electric Company, and I find the work done in a thorough and workmanlike manner. The quality of the material is good, the poles are of extra quality and well put up; in fact, the outside work reflects great credit on the men having had it in charge. The dynamo is well installed on a solid and durable foundation, and when examined by me was in a thorough and satisfactory working order. The workmanship on the regulator is particularly admirable, and on trial performed its work well, keeping up a current in both circuits perfectly even. The whole installation I consider first-class; in fact, it is a pleasure to be called in to pass judgment on work of this character.

(Signed) J. J. WRIGHT,
Toronto, Feb. 8, 1892. Inspector.

The Heisler Company also report a sale of plant at Constantine, Mich., made through their agents, Messrs. Rheubottom & Bond, of Union City. These gentlemen are doing excellent work in their territory, and are meeting with deserved success.

Queen & Company.

It is not often that electrical companies announce "Bargain Days" or "Annual Spring Sales," but an interesting circular just received would indicate that Queen & Company have decided that old stock is worse than none, and the way they have cut the prices of some ammeters and voltmeters is something heretofore unknown in the instrument business. This startling reduction, of course, does not apply to any of their regular stock, but they happen to have on hand a good many Ayrton & Perry spring ammeters and voltmeters which do not find so ready a sale now as formerly, for obvious reasons, explained in the circular, from which we quote:

When these ammeters and voltmeters were first placed on the market some five years ago, they were without doubt the best instruments made for both experimental and practical measurements. Their points of excellence were and still are—portability; absence of permanent magnets; constancy; and direct reading proportional scales. As a consequence we have supplied them to most of the large manufacturing companies, to many central stations, and to the principal college laboratories. Recently we have engaged extensively in the manufacture of ammeters and voltmeters for all purposes, and find that for exact work we can produce instruments of greater accuracy, and for station use of equal accuracy, at a less cost than the Ayrton & Perry type.

We have decided, in consequence, to insure a prompt disposal of the instruments of this make still on our shelves, and have reduced their prices 50 per cent. from last year. This reduction is made without regard to cost, and it is a rare opportunity to obtain a good ammeter or voltmeter for experimental or every day use, at a marvelously low figure.

Everybody is familiar with this type of instrument, and those wishing to take advantage of an exceptional opportunity should send to Queen & Company for a copy of Circular No. 275.

FOR SALE.

Two No. 20 500 volt Edison Railway Generators, 65 horse-power, complete, with regulating devices and in perfect working order, for $1,625 each.

Three No. 10 220 volt Edison Dynamos complete, with regulating devices and in perfect order, for $700 each.

One Hawkeye 220 volt dynamo 200 amperes for $500.

One Hawkeye 220 volt dynamo 150 amperes for $350.

Three Baldwin Steam Dummy Locomotives, from eight to eleven tons, two for $500 each—one good as new for $2,500, all of them were in daily use last summer.

Address,

Davenport and Rock Island Railway Co.,
DAVENPORT, IOWA.

THE
F. E. BELDEN MICA MINING CO.,
MINERS AND DEALERS IN
MICA.

The Mica of this Company has been put to severe tests and has proved equal in every respect to the best foreign mica, and is for sale at less price.

Office, 28 SCHOOL ST.,
Room 41. BOSTON, MASS.
F. EUGENE BELDEN, Treas.

For Sale.

ELECTRICAL PRINTERS of various makes, second-hand, but in good order. For Sale very cheap.

Apply 13 Dey street.

Put up in One Pound Cans. Price, 70 Cents per Pound.

ALWAYS READY FOR USE.
Every Electric Light Plant Should Have It.
CHAS. A. SCHIEREN & CO.,
Patentees and Sole Manufacturers
Perforated Electric Leather Belting
47 Ferry Street, New York.
119 High Street, Boston.
226 N. Third Street, Phila.
46 S. Canal St., Chicago.

MACHINERY IN STOCK.

Engine Lathes, 10 in. x 4 ft.; 11 in. x 5 ft.; 12 in. x 6 ft.; 14 in. x 6 ft.; 16 in. x 6 ft.; 18 in. x 8 ft.; 20 in. x 9 ft., with tapes attachment; 22 in. x 12 ft. and 14 ft.; 24 in. and 26 in. x 16 ft.; 30 in. x 10 ft. and 18 ft.; 36 in. and 38 in. x 20 ft.; 42 in. x 12 ft.; 56 in. x 18 ft.; 72 in. x 20 ft.; 108 in. x 22 ft. Fox Lathes, 13 in. x 5 ft.; 14 in. x 5 ft.; 15 in. x 6 ft., 18 in. x 6 ft. Turret Lathes, 12 in. x 5 ft.; 14 in. x 5 ft.; 15 in. and 16 in. x 6 ft.; 18 in. x 6 ft.; 36 in. x 8 ft.

Planers, 16 in. x 16 in. x 3 ft.; 20 in. x 20 in. x 4 ft.; 24 in. x 24 in. x 6 ft.; 30 in. x 30 in. x 6 ft.; 36 in. x 36 in. x 10 ft.; 42 in. x 42 in. x 12 ft.; 72 in. x 60 in. x 15 ft.; 72 in. x 60 in. x 20 ft.

Friction Shapers, 15 in., 16 in., 20 in., 22 in., 32 in.

Crank Shapers, 6 in., 8 in., 10 in., 12 in., 15 in., 16 in., 20 in., 24 in., 28 in.

Screw Machines, Nos. 1, 2, 3, 4, with or without Wire Feed.

Screw Machines, Nos. 5, 6, 7, 8, Power Feed.

Presses, Nos. 51, 52, 53, Ferracute, Nos. 1, 2, 3, Stiles & Parker.

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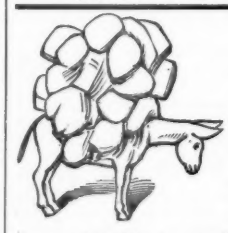

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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON FEBRUARY 16, 1892.

469,181 Electric letter box; Charles A. Pinkham, Wollaston, Mass.
469,193 Dynamo-electric machine or motor; Henry M. Byllesby, St. Paul, Minn.
469,203 Mechanical telephone; William H. Eastman, Concord, N. H., assignor, by mesne assignments, to the Pulsion Telephone Co., same place.
469,208 Electrical conduit; Edwin T. Greenfield, New York, N. Y., assignor to the Interior Conduit and Insulation Company, same place.
469,220 Electric cut-out; Van A. Thomas, Providence, R. I.

FEBRUARY 23, 1892.

469,241 Moulding for electric wires; Walter Gritten and Arthur Parmley, London, England.
469,248 Electric conductor for metallic circuits; Silas W. Holman, Newton, Mass.
469,257 Speed regulator for dynamos or motors; Luther H. Leber, Pittsburgh, Pa., assignor to David J. Richardson, same place.
469,262 Conduit for cable or electric tramways; Geo. S. Morison, Chicago, Ill., and Chas. Vogel, San Anselmo, Cal., assignors to the Vogel Cable Construction Co. of Colorado.
469,266 Electrical burglar alarm for windows; Friend C. Page, Creston, Ia.
469,273 Electric telegraph apparatus; Joseph Robinson, London, England.
469,280 Electric railway; William S. Smith, Berkeley, Cal.
469,281 Dynamo-electric machine; Johannes Sohlman, Frederikshaum, Finland, Russia.
469,283 Electric hose coupling; Joseph B. Strauss, Cincinnati, O.
469,347 Electric arc lamp; William D. Graves, Cleveland, O.
469,353 Overhead conductor for electric railways; Edward M. Bentley, New York, N. Y.
469,361 Electric elevator; Robert Watson, Brooklyn, N. Y.
469,362 Electric arc lamp; Frederick R. Boardman, Manor Park, England.
469,376 Fire alarm system; Harvey Redding, Everett, assignor to the Redding Electric Co., Boston, Mass.
469,383 Brake for electric cars; Edw. S. Amrock, Waltham, Mass.
469,408 Automatic electric gas lighting burner; Rufus C. Nourse and Thos. W. Lane, Boston, Mass., assignors to the Electric Gas Lighting Co., Portland, Me.
469,424 Electrical high and low water alarm; Alcinus C. McConnel, Allegheny, Pa.
469,428 Diaphragm for electrical cells; Chas. N. Waite, Newton, Mass.
469,438 Railway signaling apparatus; Frank I. Myers, New York, N. Y., assignor to the Hall Signal Co. of Maine.
469,441 Electro-magnetic reciprocating engine; Merle J. Wightman, Scranton, Pa.
469,469 Tube for electric conductors. 469,470 Conduit for electric conductors; Edwin T. Greenfield, New York, N. Y., assignor to the Interior Conduit and Insulation Co., same place.
469,471 Electro-magnetic stop motion for steam engines; William W. Hailstone, Long Island City, N. Y.
469,474 Telephone support; Hammond V. Hayes, Cambridge, assignor to the American Bell Telephone Co., Boston, Mass.
469,475 Electric cable; Hammond V. Hayes, Cambridge, and John S. Stone, Boston, assignors to the American Bell Telephone Co., Boston, Mass.
469,481 Electrical atomizer; Colin Lightbody, Brooklyn, N. Y.
469,482 469,483 Incandescent lamp; Frederic H. Manchester, Providence, R. I.

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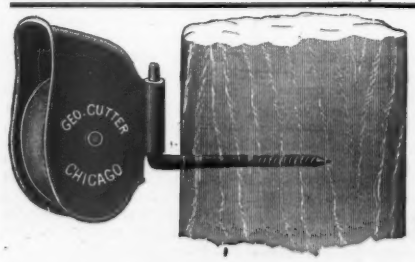

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